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Review of South African experience in rural electrification

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- Durban Electricity
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- Energy & Development Group
- Energy & Development Research Centre
- Eskom: Agrelek
- Eskom: Bloemfontein
- Eskom: Cape Town
- Eskom: Distribution Technology
- Eskom: Durban
- Eskom: East London
- Eskom: Megawatt Park
- Eskom: National Electrification Planning
- Eskom: Nelspruit
- Eskom: Phalaborwa
- Eskom: Pietersburg
- Eskom: Pretoria
- Eskom: Technology Research & Investigations
- Independent Development Trust
- Venda Development Corporation: Electricity Division

Executive summary

Rural areas and electrification: the current status

'Rural' areas in the South African context are not easily defined. The definition used in the National Electrification Forum (NELF) database, namely that rural areas constitute all areas which do not fall within promulgated local authority boundaries, is often referred to in this paper. However, this definition of 'rural' areas includes many large and fairly dense peri-urban settlements, particularly in the former homeland areas. The term 'functionally urban' has thus been introduced, which refers to all settlements with a population larger than 5 000, irrespective of their having municipal status. According to the NELF database, an estimated 12% of the houses and 11.5% of the population in rural areas are supplied with grid electricity. However, the percentage of households outside of functionally urban areas with access to grid electricity is likely to be less than 12%.

Because of the lack of accurate demographic and planning information on 'rural' areas, it is currently only possible to make a broad distinction between two categories of households: residents in the former homelands, and farmers, farmworkers and their families who live on commercial farms. Demographic information on farmworker households is particularly unreliable. Current estimates are that about a quarter of farmworker homes, and a smaller proportion of farmworker *households*, have been electrified to date.

Eskom is the main electricity distribution agency in rural areas, and the only one which operates nationally. It is also the most significant player involved in the electrification of farmers and farmworker households. The other distributors involved in rural electrification in more than a peripheral manner are Durban Electricity, the Venda Electricity Corporation (VEC) and the Bophuthatswana Electricity Corporation (BECOR). However, their involvement is limited to particular areas. Both BECOR and VEC will probably be taken over by Eskom.

The supply of Remote Area Power Supply (RAPS) systems in South Africa is almost entirely in the hands of the private sector, and is done through a network of agents and suppliers. It is estimated that 40 000 to 60 000 household photo-voltaic (PV) systems and 2 000 to 4 000 PV water pumps have been installed in South Africa to date, while an estimated 500 to 700 schools and clinics have been electrified with PV systems.

The national household grid electrification programme

A national household grid electrification programme commenced in the early 1990s. National targets for the distribution industry were established during deliberations of the National Electrification Forum (NELF) in 1993 and 1994. In 1994 the target was 350 000 new connections, building up to 450 000 in 1996. The targeted annual number of connections remains constant at 450 000 until the year 1999, after which it starts to decline. Eskom has committed itself to achieving close to 70% of these targets. These targets are expected to lead to an increase in access to electricity from 44% of households in 1994 to 65% in the year 2000. It is difficult to assess the proportion of rural households which will be electrified as part of this programme. However, it is likely that most of the remaining un-electrified households at the turn of the century will be living in rural areas. In particular, access to electricity amongst farmworkers is unlikely to increase significantly, as it is not given priority in the programme.

More than one million houses had been electrified as part of the programme by mid-1995, including farmworker houses and houses electrified by urban municipalities. If it is assumed that approximately 70% of the connections made by Eskom from 1990 to 1994 have been in 'rural' areas, the number of rural connections made during this time would amount to about 447 500. This constitutes about 11% of the total number of houses in rural areas as indicated in the NELF database. By comparison, an estimated 45 600 farmworker houses have been connected by Eskom during this time.

Different estimates of the cumulative capital requirement of a national household electrification programme have all placed this within the range of R22 to R28 billion (1993 rands), depending on the particular assumptions made. These totals correspond to an annual

capital requirement of R1.2 to R1.5 billion, of which approximately R1 billion would be spent by Eskom. Estimates of the operating costs and consequent financial impact of the electrification programme, however differ substantially.

Eskom is well-placed to utilise cross-subsidies and raise finance from the capital and money markets for its electrification programme. The principle finance mechanisms used by Eskom are long term (more than three years) fixed interest bonds. However, the financing of non-Eskom electrification remains one of the most significant obstacles facing the successful implementation of the national electrification programme.

Eskom's household grid electrification programme

Eskom's approach to household electrification is characterised by its policy to connect all households in settlements which are electrified, coupled with the use of a tariff comprising a low connection fee and an energy charge, with no fixed monthly charge. Electrification has generally been done in accordance with Eskom's current electrification standard, with houses being provided with a 60 A or 40 A supply. Metering is generally done using prepayment meters. However, some of these policies are currently under review in the light of the experience of the last few years.

The experience to date: consumption, costs and losses

One of the main problems experienced by Eskom has been the high cost of electrification and the high distribution losses which have been incurred in the face of consistently low consumption rates. Theft of electricity through the bypassing and tampering with prepayment meters is a major problem, although it appears to be of less concern in rural areas compared to urban areas. The greatest problems pertaining to rural areas appear to be high capital costs (the average costs in the Durban distributor area have been close to R5 000 per connection), as well as high operating costs (including supply and support costs). However, the latter seems to be of equal concern in urban areas, as support costs in the Johannesburg distributor area are currently as high as R32 per customer per month.

A range of strategies are being put into place to address these problems. This includes the monitoring of bulk supply to settlements to detect discrepancies between sales and consumption figures, and then identifying non-paying customers from sales records. In addition, Eskom has set itself the target of reducing the average capital costs per connection to R2 180 (in 1995 terms) by the year 2000, mainly through the use of innovative technologies and the introduction of new technical standards. However, the concern has been raised that this short-term cost reduction strategy could compromise longer-term cost optimisation, which may have serious implications for the continuation of the electrification programme after the year 2000.

Furthermore, Eskom aims to reduce the average support cost to R15 (in 1995 terms) per customer per month over the next few years. The principle strategy to reduce supply costs which is aimed at low-income households, is to limit the current available for low consumption loads. The current aim is for about 85 000 of the connections that will be made in 1996 to be done using low-cost technologies and current limiters. The use of 2.5A current limiters in remote areas, coupled with a flat-rate tariff, is being investigated in a number of pilot projects.

Electrification planning

No institutional framework currently exists to facilitate national electrification planning for the distribution sector as a whole. Eskom, as a public utility which is responsible for more than two thirds of the national electrification programme, is thus planning and conducting what is in fact a government-sanctioned and highly subsidised national electrification programme, virtually on its own. The utility has itself indicated that it expects of the government to provide a framework for electrification planning.

Planning processes in Eskom have been evolving continually since the onset of the electrification programme. There has also been substantial variation in the way planning has been done in different regions. Five-year planning is conducted annually, and involves setting targets and compiling budgets per province, and in some cases for sub-regions within larger

provinces. These targets are set in consultation with national and provincial stakeholders, but the details of this process are not clear.

Five-year planning also involves the development of a masterplan for each region. The way in which this was done in the past varied considerably, particularly as concerns rural areas. The approach in most areas has been to incrementally expand the grid, electrifying communities on a least capital-cost basis. Plans were submitted to electrification forums where these existed, in most cases merely with the purpose of informing the organisations involved of Eskom's plans. However, in the former homelands of Lebowa and Gazankulu, electrification forums actually compiled priority lists of settlements in each district to be electrified over a five-year period. These lists were modified to varying degrees during negotiations between Eskom and the forums. As the plans did not take the existing network into consideration to any significant degree, the capital costs of projects have probably been higher than they could have been if a different approach had been taken.

Planning processes were recently reviewed by an internal working group, which recommended that a standardised planning process should be introduced in the organisation. The aim is to have this process in place by the end of 1995. The most significant aspect of the process is that a least-cost electrification plan will be developed for each region as a first step, based on technical and financial considerations such as the constraints on capital expenditure. These plans will form the basis of any negotiations with stakeholder bodies. The main constraint facing Eskom in the implementation of this process is the lack of adequate demand- and supply-side information at present, particularly concerning rural areas.

Two-year and one-year plans are currently reviewed and approved by Eskom's Capital Investment Committee (CIC) on a quarterly basis, using a 24-month and 12-month moving window respectively. Eskom's head office requires that each project proposal passes a financial rate of return criterion (presently set at 6% real per annum over 15 years), as well as achieving at least 8% real economic return. These guidelines have not been strictly applied, however, due to the pressure to achieve the national targets.

Information used in the financial and economic analyses has also generally been unreliable. Eskom has recently launched a number of initiatives to improve demand-side information required for planning as well as marketing purposes, such as the development of the Housing and Electrification Planning (HELP) database, and the national panel survey conducted by the marketing division. An initiative is also underway to assist with the identification of settlements where the proposed load limited supply options could be implemented.

Consultation with stakeholders

Consultation with stakeholders has generally taken place within electrification forums which had been initiated and facilitated by Eskom. In most cases their activities were mainly restricted to information sharing (on Eskom's plans, for example), as well as the discussion of matters concerning the electrification industry. The two main exceptions seem to have been the regional forums operating in the former homelands of Lebowa and Gazankulu respectively. However, a number of problems have been experienced with these forums. For example, the legitimacy of the forums has been in dispute, and their decisions concerning the prioritisation of projects have often been questioned by other parties in these areas.

Eskom's consultation policy has been reviewed during the last year in the light of these problems as well as the recent political and institutional changes in the country. The most significant changes which have been proposed, are the following: (1) official collective forums which are established, for example, by the provincial Reconstruction and Development Programme (RDP) offices, should in future be used for the prioritisation of areas and projects for electrification; and (2) forums should only be able to institute changes to Eskom's least-cost plans if these have no financial implications, or if additional funds from an other sources are made available to cover additional costs. In addition, the need for a national framework concerning the consultation processes used in the planning of electrification, which has political legitimacy and is underwritten by the government, has been raised by Eskom.

It is significant that no provision has been made in the past for consultation with representatives of farmworkers concerning electrification planning. This reflects, and

probably also contributes to the low priority given to this group in the national electrification programme. Finally, although local electricity committees are established by Eskom to facilitate communication with the communities which are electrified, no provision is currently made for the involvement of communities in the planning of electrification projects.

Other household grid electrification programmes

Smaller household grid electrification programmes which have involved some electrification in rural areas, include the *Electricity for all* programme undertaken by Durban Electricity, which forms part of the national programme, as well as the ongoing programmes run by the utilities of the former Venda and Bophuthatswana homelands. Information on the electrification programmes of most of the former homeland distributors is difficult to come by, for reasons such as the poor management of these institutions and inadequate reporting procedures, as well as the recent demise of most of them.

In general, these programmes appear to have focused mainly on areas which could be regarded as 'functionally urban', as opposed to 'deep rural' areas. Different connection policies, tariffs and metering options have been employed by the various utilities, which often differ from those currently employed by Eskom. This generally makes comparison between programmes very difficult, for example, comparison with respect to costs, take-up rates and consumption rates.

Furthermore, most of these smaller programmes, particularly those conducted by the former homeland utilities, have been poorly documented, in addition to being poorly planned and managed in many cases. As a result, little benefit has been derived from their experience to date. Nevertheless, some aspects of the smaller electrification programmes may be of value to the development of future policies. For example, BECOR's experience with respect to the implementation of load limited supply and circuit breaker tariffs may be of value in light of the proposed changes in Eskom's approach.

Farmworker electrification

Eskom's current approach to farmworker electrification

Farmworker electrification is not a priority of Eskom at present, as the organisation mainly sees itself in a supporting role in this area. Farmers themselves and provincial and district authorities, such as the Regional Services Councils (RSC's) in recent years, have been expected to drive the electrification of farmworker houses.

Eskom's current policy on farmworker electrification makes provision for four methods by which farmworker houses can be electrified. The one used most commonly - and the only method employed in the Free State programme discussed below - allows for a once-off contribution by Eskom to the value of R400 per house which is electrified, which generally includes an appliance to the value of R100. Eskom is allowed to market electricity and provide education to the farmworkers using electricity. Consumption by the farmworkers is included in the farmer's electricity bill, using the Landrate tariff, and the responsibility for the payment of electricity lies with the farmer. The farmer owns the electricity supply to the farmworker houses, and is responsible for maintenance.

A number of questions can be raised about the way in which Eskom is currently dealing with farmworker electrification, which basically stems from the fact that the utility has seen itself in a supporting role in this regard. One of these is the absence of a properly planned and co-ordinated national farmworker electrification programme, with specific objectives and allocated responsibilities. At present the responsibility for this activity within Eskom lies mainly with Agrelek advisors whose primary objective is to increase the sale of electricity on farms. They have very little incentive, therefore, to focus on farmworker electrification which involves low levels of consumption. As a result, farmworker electrification is not given a high priority by them, and is generally done in an ad hoc manner.

In cases where regional farmworker electrification programmes have been implemented on a relatively large scale, for example in the Free State and the Western Cape, the initiative taken by the regional Eskom offices seems to have been one of the important factors contributing to

the success achieved. However, an approach which leaves this matter to the initiative of individuals within the organisation, is unlikely to achieve significant improvements in farmworkers' level of access to electricity, as is evident from the current connection rates pertaining to farmworkers.

Current developments in Eskom's approach

The current situation with respect to farmworker electrification has been reviewed by a national Eskom task team, which is in the process of compiling a proposed strategy. The following are likely to be some of its key recommendations: (1) Eskom should formulate a national policy on farmworker electrification in consultation with the national RDP office, which establishes the priority which should be given to this activity, as well as the manner in which it will be financed; (2) an Eskom manager should be appointed with overall responsibility for this activity at a national level; and (3) the Eskom personnel who will be responsible for this activity should be set goals which are in accordance with aims of the initiative and its regional or national priority, and are not strictly sales-related, as in the case of Agrelek advisors.

If these measures were implemented it would significantly improve the current situation with respect to farmworkers' access to electrification. However, it may also be necessary to assess some aspects of the current Eskom policy on farmworker electrification if this would be retained.

Farmworker electrification in the Free State

Most farmworker electrification in the Free State is done through a joint programme between Eskom and three of the four RSC's in the province. Eskom is essentially acting as an agent for the RSC's, which are providing most of the financing for the programme. The capital subsidy provided by the RSC's range from R1200 to R1600 per house, subject to constraints in some cases. The actual cost per connection is just greater than R2 000 on average in cases where an existing point of supply can be used, while the highest cost per connection in a project electrified as part of this programme, has been R3 500.

Since its inception in 1989 until the end of May 1995, a total number of 14 612 farmworker houses have been electrified as part of the programme, using grid electricity. This constitutes about 27% of all the farmworker connections which have been made by Eskom nationally. In addition, 108 schools and clinics have also been electrified as part of the programme to date.

The programme in the Free State also makes provision for the electrification of farmworker houses using photo-voltaic systems, for which similar subsidies are provided by the RSC's. Since 1991 a total of 713 houses have been electrified as part of the programme in the Free State using PV systems, including 172 in the first five months of 1995.

Schools and clinics electrification

Current initiatives to electrify community facilities focus mainly on clinics and schools, which have been given priority by the government. Two major initiatives exist which focus on the electrification of schools and clinics, and provide financing for such projects: the Independent Development Trust (IDT) clinic electrification programme, and Eskom's schools and clinics grid electrification programme. In addition, the Non-grid Electrification Group in Eskom's Technology Research & Investigations (TRI) has recently embarked on a RAPS electrification programme aimed at schools and clinics.

The IDT's clinic electrification programme

The IDT is involved in rural clinic electrification in a number of ways, which include the following: (1) the funding of the 'un-economic portion' of the extension of the electrical network by utilities to rural settlements where there are clinics; and (2) the provision of the full electrical supply for off-grid clinics, including the power supply, wiring, lighting and some equipment, as well as the electrical system for nurses quarters associated with off-grid clinics. The IDT has been more directly involved with off-grid supply than grid electrification, which has generally been conducted by the utilities using IDT funding. Depending on the location of a clinic in relation to the electricity network, it is either provided with grid electricity,

a combination of a genset-plus-battery system and liquid petroleum gas (LPG) vaccine refrigeration, or full PV electrification. The clinic PV system is designed based on general clinic system performance requirements, as well as a demand assessment informed by a visit to each site.

About 252 clinic electrification projects funded by the IDT are underway or have already been completed, comprising about 28% of the estimated 900 existing un-electrified clinics. It is not clear how many clinics the IDT is planning to electrify in its programme, however, although the overall target is to achieve 85% electrification of all clinics. The programme has largely concentrated on residential clinics to date, although programmes to address the energy needs of smaller clinics and visiting points have also recently been launched. The total funds which have been allocated by the IDT to capital expenditure on clinic electrification, are R 54 million. A further R 4.5 million has been set aside for the longer-term maintenance of off-grid clinic electricity systems.

The IDT programme makes extensive provision for the maintenance of off-grid systems, as this is recognised as essential to ensure long-term sustainability. As a part of the contractor's obligations, the entire PV system is guaranteed for 12 months, while the contract also requires that PV panels be guaranteed for 10 years. The IDT has also established a Joint Maintenance Fund, in which money is deposited for continued maintenance of installed clinic PV systems for the next 10 years. This amounts to approximately R 15 000 per clinic.

Ownership of off-grid clinic energy systems is linked with responsibility for longer-term operation and maintenance of systems, and is therefore a crucial issue. Initially, communities were intended to be the recipients of the IDT funded systems, but since they do not have the resources to maintain the systems, these are to be handed over to provincial Departments of Health or Works. As all systems installed are still within their one-year guarantee period, however, the practicalities of how the longer-term maintenance arrangements will work, are still untested.

Overall, the impact of the IDT's clinic electrification programme has been significant. Systems installed are generally performing well, and clinic staff and regional health personnel have often expressed their satisfaction with the results. A noteworthy achievement is the development of a reproducible procedure for clinic PV electrification which ensures quality systems. It can be argued that, given the chequered track record of PV installations both nationally and internationally, a very solid engineering approach was justified to make sure that the projects were successful. Other models for implementation should also be explored, however, e.g. the industry taking greater responsibility for installation quality, or increased use of Eskom as consultants. Both of these routes are currently being followed by the IDT.

Nevertheless, the IDT programme is a relatively young one, and the success of the programme in terms of providing sustainable systems of energy supply to clinics, will need to be assessed in the future.

Finally, it can be argued that the role of the IDT in the planning, co-ordination and implementation of clinic electrification as part of its clinic building and upgrading initiative, is inappropriate as these functions should be performed by the national and provincial Departments of Health. The IDT had itself initially expected to play the role of funder in the clinic electrification process.

Eskom's schools grid electrification programme

Eskom's programme mainly focuses on the electrification of schools, although some clinics are also being electrified. Eskom originally planned to electrify 400 schools and 100 clinics per year as part of its grid electrification programme. However, the actual number of schools and clinics which had been assisted in some way through the Eskom programme were 583 in 1994, and the current target for 1995 is about 880. Clinics only form a small proportion of these numbers.

Schools have to apply to Eskom for assistance, which may take a number of forms, including the extension of the grid to the school, connecting the school, and/or providing internal wiring. Priority is given to the connection of schools and clinics in areas which have already been electrified. Apart from light fittings which are included in the cost of internal wiring, no

funds are made available for the purchase of appliances, as this is the responsibility of the provincial Departments of Education.

Funding for the programme is obtained from different sources. Eskom has committed approximately R15 million from the 1995 Community Development Fund towards the electrification of schools and clinics, while a further R15.2 million had been donated by the Norwegian Agency for Development Co-operation, and is being administered by Eskom. The electrification of schools and clinics is also financed through the household electrification programme, as any clinics or schools within the scope of current electrification projects are connected as part of this programme. In some cases where clinics are located within a distance of about five kilometres from the grid, funding for extension of the grid has been obtained from the IDT clinic electrification programme. A process of review is currently underway with the aim to improve planning and accounting procedures, establish clear criteria for the approval of projects etc.

It is difficult to assess the extent to which the programme has been successful to date, particularly as no clear objectives exist for the programme. It is important to note that the schools electrification programme does not form part of a larger initiative to upgrade facilities and improve education at schools, as is the case with the IDT clinics electrification programme. No clarity exists on the type of facilities requiring energy which are needed and will be provided at different schools, for example, audio-visual equipment, security lighting, and kitchens for home economics classes. Provincial Departments of Education are generally responsible for providing electrical equipment at schools, but it appears that little is being done in this regard. Given these conditions, it is likely that the impact of schools electrification on the improvement of educational services in rural areas will be very limited in the short term. However, even in the longer term the impact may be very limited, as other constraints to improving education are likely to be of much greater consequence.

Furthermore, although the utilisation of schools for night classes, for example as part of adult education programmes, is generally seen as an important reason for the electrification of schools, it is not clear to what extent electrified schools are being used for this purpose.

TRI's schools off-grid electrification programme

During 1994 the Non-grid Electrification group in Eskom's Technology Research & Investigations (TRI) launched a schools electrification programme which will utilise off-grid technologies. It has undertaken to electrify 1000 schools by March 1996. The approach that will be taken and the procedures to be followed, are still being developed.

Funding for the programme is expected to come primarily from foreign development assistance, some of which will be channelled through the RDP fund. In the short term, funding has been obtained from Eskom's Community Development Fund, which has amounted to about R2.5 million to date.

Although maintenance arrangements have not yet been finalised, it appears that TRI will be following a very different approach from that which has been established by the IDT. For example, the provincial Departments of Public Works may be expected to provide for maintenance costs in their annual budgets.

A concern which has been raised about the programme, is that system design may not be adequately informed by potential energy requirements at schools. It appears that only limited direction has been provided by the Department of Education in this regard, while needs assessments undertaken as part of the programme to date have been of a fairly limited nature. Currently provision is made for lighting in three classrooms, the staffroom and principal's office, as well as one or two power outlets for a television, video, overhead projector etc. The average cost per installation, excluding electrical equipment, has been estimated as between R40 000 and R50 000. However, it is uncertain whether audio-visual and other equipment will be made available to schools in the future.

In conclusion, it should be noted that the specific focus on clinics and schools electrification constitutes a serious limitation of current programmes aimed at electrifying community facilities in rural areas. Two other important services in rural areas, public lighting and water supply, are not adequately provided for in current electrification programmes. Public lighting

is generally not provided in rural settlements, mainly because there are no authorities which can take responsibility for the payment of such services. Furthermore, no specific initiative to co-ordinate water supply planning with electrification is currently underway.

Electrification of small-scale agriculture

Meeting the electricity needs of the agricultural sector, including the provision of advice and assistance concerning the utilisation of agro-electro-technologies, has in the past been the responsibility of Agrelek, Eskom's advisory service to agriculture. Agrelek currently has a network of about 80 advisors nationally, who have mostly been serving the large commercial farming sector comprising mainly 'white' farmers. A very different situation is now unfolding, with government policy emphasising the development and support of small-scale agriculture. Agrelek has also launched a Small and Medium Scale Farmer (S&MSF) initiative with the short-term objective to conduct rural electrification pilot projects to enable Agrelek to develop and test strategies to assist the sector. However, progress with pilot projects has been severely hampered by a lack of financing, and to date limited projects have been implemented by Agrelek.

There are significant differences between the circumstances and needs of Agrelek's traditional target group and small-scale farmers, including the scale of operations, access to resources, technologies used etc. The system of using Agrelek advisors as the primary contact with farmers was probably appropriate in an environment where the primary need for energy or electricity in the often sparsely populated commercial farming areas was for agricultural purposes. Most small-scale farmers, however, are presently located in relatively densely populated areas in the former homelands where the primary use of energy is for domestic purposes. In many cases the provision of electricity for agricultural purposes may therefore need to form part of an electrification project in a largely residential area.

If particular energy needs of small-scale farmers are to be met through the current electrification programme, some form of restructuring of functions within Eskom would probably be required to ensure the proper co-ordination and integration of electrification planning generally and the electrification of small-scale agricultural activities in particular. This would also require that agricultural needs are given a higher priority in Eskom's current rural electrification programme. Furthermore, the tariff policy pertaining to the agricultural sector may need to be reviewed to facilitate access to electricity amongst small farmers.

It should, however, be pointed out that the current obstacles within Eskom which prevent the needs of the small-scale agricultural sector from being addressed adequately, are related to problems of a broader nature in the agricultural sector, particularly the absence of a co-ordinated national programme to support and develop small-scale agriculture. Although a number of initiatives are being undertaken in the sector, these have not yet been translated into a broad-based programme. As a result, matters such as the following have not been adequately addressed as yet: (1) A national policy framework concerning agricultural development and energy provision, which defines the particular role of electrification in agricultural development in relation to other forms of energy; (2) an institutional framework for the provision of support services to small-scale farmers, including support pertaining to the utilisation of energy and electrification; (3) the lack of planning information concerning small-scale agriculture; and (4) the lack of access to credit amongst small-scale farmers.

Discussion and conclusions

Clearly a lot of experience has been gained with respect to rural electrification in South Africa, which is informing debate, critical review of current approaches, and future planning. In conclusion, a number of issues concerning rural electrification which are regarded as being of particular importance, will be highlighted.

A rural development framework for rural electrification

The absence of a national rural development framework for rural electrification, which sets out the role of electrification in rural development, as well as the specific development objectives of rural electrification programmes, and with this identifies priorities for rural electrification on the basis of development priorities, is very evident from this review. The

IDT clinic electrification programme is the only exception to this, as this programme was conceived and planned as part of the IDT's broader rural development activities.

In line with its emphasis on the needs of the poorest in society, the IDT's focus in rural electrification has been on clinics which provide an essential service to all people, and therefore tend to spread the benefits of electrification more equitably amongst all residents of an area as compared to household electrification.

By comparison, the focus of the current national electrification programme is on the electrification of households, and, in rural areas, specifically households in the former homelands. In addition, schools and clinics have been identified as priorities for rural electrification. It is not clear *on what grounds* these have specifically been identified as priorities, rather than farmworker households, for example, or water supply in rural areas, or small-scale agriculture. Certainly the priorities have not been established by Eskom alone, as the national government has emphasised the electrification of schools and clinics in addition to household electrification. One could question the priority placed on schools electrification in particular, as electrification is probably one of the least critical inputs to improve the quality of education in South Africa. On the other hand, the virtual absence of small-scale agricultural and water pumping needs from current programmes probably need to be reviewed urgently.

The overall aim of the IDT clinic electrification programme has been the improvement of health services in South Africa. Following from this, electrification or energy planning has been conducted with the aim to meet specific needs in the health sector, such as vaccine refrigeration to sustain the cold chain. By comparison, no similar specific objectives have been formulated for the national electrification programme, or the schools and clinics electrification programmes conducted by Eskom. These programmes are essentially electrification programmes and not development programmes. The aims have been defined in terms of numerical targets, and not in terms of particular development needs. For example, schools are being electrified without a clear understanding of the facilities which will realistically be provided to these schools in the future. In the case of off-grid electrification this is of particular concern, as the system design load can have a significant impact on the costs of an installation.

Co-ordinated rural development and electrification planning

It is further evident from this review that very little effective co-ordination between rural development and electrification planning is taking place at present. Again the IDT has been able to overcome some of the obstacles in this regard. It has taken a fairly integrated approach to the improvement of health services in rural areas, of which the provision of energy forms only one component. Clinics have thus been upgraded and provided with the necessary equipment at the same time as energy has been provided, to ensure that the quality of the service is improved. The IDT has also been constrained by inter-sectoral barriers, however - for example, it has only recently broadened its involvement with clinics to include water supply.

The national electrification programme, on the other hand, is not located within an integrated development programme. It is mainly driven by the electricity distribution industry, and Eskom in particular. Although attempts are made to involve other parties concerned, such as the Departments of Health and Education in the electrification of schools and clinics, the electrification programme is much further advanced than programmes to improve services in some other sectors, with the result that very little co-ordinated planning is taking place. Small-scale agriculture in particular is at danger of being marginalised by the current electrification programme because of the underdeveloped state of planning for this sector. This situation is compounded by the fact that government structures to facilitate development co-ordination at provincial level are still in the process of being established. In this context the appropriateness of national electrification targets which have to be met irrespective of progress in other development sectors, needs to be questioned.

An integrated energy planning framework for rural electrification

The absence of a national policy framework to facilitate integrated energy planning in South Africa is also evident from this review. For example, planning with respect to off-grid electrification is hampered by the lack of clear national criteria for identifying areas which are to be electrified by the grid. At present the only criteria which can be used, are the distance of a settlement from the current grid and whether a settlement is included in plans to extend the grid, while information on these matters are often inadequate. The IDT, being concerned with meeting the energy needs of clinics in a cost-effective and sustainable manner, has developed a simple set of guidelines for the selection of particular supply options, including the use of LPG, RAPS systems and grid electrification.

A recent aspect of Eskom's rural electrification policy has been a commitment to 'integrated energy planning', whereby other supply and demand strategies are considered as alternatives or complements to electrification. This is gaining particular importance in the light of the proposals to provide load limited supplies in a significant percentage of the areas which will be electrified in the future. However, it is unlikely that such an approach could be driven successfully by an organisation aligned with a particular energy carrier, as is the case with Eskom.

It is generally accepted that electricity will not meet the bulk of energy needs in rural areas in the short to medium term, and other programmes have been initiated to address broader energy needs, such as the social forestry programme presently funded and managed as part of the IDT's Rural Energy Programme. However, energy service provision in rural areas is still characterised by a piecemeal approach, and it is unlikely that energy needs and problems will be met in a comprehensive and consistent manner unless a national policy and institutional framework for integrated energy planning is put into place.

An institutional framework for electrification planning

Another significant gap which is evident from this review, is the lack of an institutional framework for electrification planning, with clear roles for different players in this field, including government structures at national, provincial and local levels. The role which local government in rural areas could play in electrification planning and development co-ordination generally, requires specific attention.

At present electrification planning for rural areas is essentially conducted by the IDT and Eskom, both of which are public sector institutions with very specific missions. The IDT was formed to address poverty and the needs of the poorest, for which it utilises grant funding from the state. Eskom, on the other hand, is a public utility which has been charged with the cost-effective supply of electricity to South African consumers, and finances itself through the capital and money markets.

Eskom in particular, being responsible for two-thirds of the national electrification programme, is planning what is in fact a government-sanctioned and highly subsidised national programme, and is effectively developing national electrification policy for rural areas, with very little direction from national government. However, as reflected in the discussion above, Eskom is not an appropriate institution to take responsibility for rural electrification policy and planning. The utility itself has indicated that it expects of government to provide a framework for rural electrification planning. However, in the absence of the necessary institutional and regulatory arrangements which will enable government to set rural electrification policy and to oversee its implementation, some vital decisions are being made within Eskom - for example with regard to targets for reducing capital costs, which could have far-reaching implications for rural electrification in the future.

Finally, a crucial aspect that needs to be considered, concerns the implications for rural electrification planning of a decentralised approach to development planning in rural areas, and particularly the implications of such an approach for the way in which the financing of rural electrification projects is structured. For example, it may be necessary to place more control over the financing of electrification projects at a local level.

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1. Introduction

This paper attempts to summarise the current status of rural electrification in South Africa, and to provide an overview of the experience with respect to rural electrification to date. A number of current electrification programmes are discussed in some detail, focusing on aspects regarded as being of particular importance in each case. An attempt is also made to identify some key issues concerning the manner in which rural electrification is approached at present.

However, this paper does not presume to present an exhaustive assessment of rural electrification experience in South Africa to date. Some degree of selectiveness has been necessary, particularly with respect to the matters which are discussed in greater depth. Selection was generally determined by the availability of information, as well as the degree to which this information was generally accessible. So, for example, information on the electrification programmes conducted by most of the former 'homeland' utilities is generally not easily accessible, and in some cases not available at all. As a result, relatively little attention has been given to these programmes. On the other hand, information on the IDT clinic electrification programme was readily available, although not in a form that was generally accessible. This programme is therefore described in some detail in this paper, with particular emphasis on the off-grid component of the programme.

In general it has been attempted to give equal emphasis to grid and off-grid electrification, although this has not always been possible due to the lack of information on off-grid installations, as well as the fact that the main emphasis in rural electrification programmes to date has been on grid electrification.

It is further recognised that many questions about rural electrification programmes in South Africa have been left unanswered by this paper - for example, questions concerning the impact and effectiveness of electrification programmes in rural areas. There is clearly a lot of information which, although not currently accessible, could be obtained with the necessary research effort.

1.1 Paper outline

The current status of electrification in rural areas is discussed in Chapter 2, including the level of access amongst different categories of users, the nature of the distribution industry which are concerned with rural areas, and the status of off-grid electrification in South Africa.

The national household grid electrification programme which commenced in the early 1990s is discussed in Chapter 3, including the targets which have been set, progress to date, and the financial implications of the programme. In Chapter 4 Eskom's household grid electrification programme, which represents more than two-thirds of the national programme, is discussed with particular emphasis on the experience to date with respect to consumption rates, costs of electrification, and distribution losses, as well as electrification planning and consultation with stakeholders in the planning process. The next chapter provides a brief overview of a few of the smaller household grid electrification programmes in South Africa.

Eskom's current approach to farmworker electrification is discussed in Chapter 6, together with the current developments in this area. In Chapter 7 three initiatives concerned with the electrification of schools and clinics are discussed, including the Independent Development Trust (IDT) clinic electrification programme, as well as initiatives within Eskom concerning grid and RAPS electrification of schools in particular. Chapter 8 gives a brief overview of the current status of Eskom's initiative to electrify small-scale farmers in the context of broader agricultural development in South Africa. Finally, issues of particular importance which have been raised in this review, are summarised and discussed in Chapter 9.

2. Rural areas and electrification: the current status

2.1 Defining 'rural' areas

Although this review is expressly concerned with electrification in 'rural' areas, it is recognised that 'rural' in the South African context is not easily defined. There is at present no single generally accepted definition of what constitutes 'rural' in this country, and various institutions have defined 'rural' in different ways. Moreover, it is probably not meaningful to attempt to make a simple distinction between 'urban' and 'rural' areas. Settlements in South Africa vary greatly with respect to size, density and spatial layout, and can be said to form a continuum ranging from sparsely populated farming areas, on the one hand, to densely populated metropolises, on the other.

The definition which will be mainly relevant to this document is that used in the National Electrification Forum (NELF) database, namely that rural areas constitute all areas which do not fall within promulgated local authority boundaries. This means that most areas in the former homelands, where relatively few towns have local authorities, are regarded as 'rural'. In the rest of the country, all areas outside of towns, such as the commercial farming areas, are regarded as 'rural'. Most of the statistics on rural areas reported in this paper have been drawn from this database, which is used by Eskom for planning purposes. However, it should be noted that 'rural', if defined in this way, includes many large and fairly dense 'peri-urban' settlements, particularly in the former homeland areas, which are in some cases located on the outskirts of large urban centres. In order to accommodate such areas in the definitions of urban and rural, the term 'functionally urban' has been introduced to include all settlements with a population larger than 5 000, irrespective of their having municipal status (DBSA 1991).

For planning purposes it is necessary to know the percentage of rural people or households living in different categories of settlements, as the density, size and location of settlements have a significant impact on the level and costs of services which can be provided. However, with the information currently available it is only possible to make a broad distinction between two major groups of people who live in 'rural' areas: residents in the former homelands, and farmers, farmworkers and their families who live on commercial farms. This classification is based more on broad differences in the socio-political conditions between the former homelands and the commercial farming areas (e.g. the former mainly comprises state-owned land presided over by Tribal Authorities, while the latter mainly comprises privately owned land on which workers live in a relationship of dependency with the landowners) than differences in settlement patterns, although the latter is also evident. However, this classification not only hides a variety of settlement patterns, but also a range of socio-political conditions within each of these categories, and is therefore highly unsatisfactory. Examples of these are the 'coloured reserves' in the Northern and Western Cape, labour tenants on commercial farms, and 'black-owned' freehold land.

Demographic information on the rural areas is generally not very detailed or accurate. The situation is particularly bad in the case of farmworkers, where the error in estimates of the total number of farmworker households living on farms may be as high as 100% (see below). This should be kept in mind when any statistics on farmworkers are discussed.

2.2 Access to grid electrification in rural areas

It has been estimated that at the end of 1994, there were close to 8.4 million households in South Africa with an average household size of 4.6 people (Eskom 1995f). Of these households, 44% was estimated to have access to electricity, equivalent to 40% of the total population. Using the definition of rural contained in the NELF database, the rural population accounted for 52% of the population and 47% of the houses. (This can be compared with the estimate by the Development Bank of Southern Africa (DBSA) that 65% of South Africa's

population is functionally urbanised (DBSA 1994.) Within this rural group, an estimated 12% of the houses and 11.5% of the population have electricity. However, considering that 'functionally urban' areas are included in the NELF definition of 'rural' areas, the percentage of households outside of functionally urban areas ('deep rural' areas) with access to electricity is likely to be less than 12%. The provincial breakdown of electrification statistics is given in the table below.

Province	Population ¹ (000)	Houses (000)	Rural population	Access to electricity ²		
				Urban	Rural	Total
E Cape	6 504	1 357	70%	59%	2%	20%
E Transvaal	2 673	531	70%	51%	20%	30%
Gauteng	6 434	1 575	4%	73%	53%	72%
K/Natal	8 137	1 673	60%	72%	7%	32%
North West	3 182	665	70%	63%	9%	25%
N Cape	760	171	30%	70%	33%	59%
Northern	4 944	997	90%	70%	14%	19%
Free State	2 495	554	42%	60%	20%	43%
W Cape	3 557	863	15%	85%	46%	80%
Total	38 687	8 386	52%	70%	12%	40%

1 Excludes people living in institutions (hostels, old-age homes, etc.)

2 Based on population ratios, not housing ratios

TABLE 1: Electrification statistics as at 31/12/94

Source: Eskom (1995f)

The provinces of KwaZulu-Natal, Northern Province and Eastern Cape, which contain the bulk of the former homeland populations, all have rural populations of more than four million and together account for 70% of South Africa's rural population. These three provinces also have some of the lowest levels of rural electrification.

2.2.1 Farmworker households

Although farmworker households are included in the above table, it is necessary to consider their access to electricity separately from the total rural population, as they comprise a relatively small percentage (12%) of the total number of rural houses indicated in the NELF database. According to the NELF database there are roughly 488 000 farmworker houses on farms in South Africa. Hofmeyr (1994), on the other hand, has estimated the number to be 550 000, and the number of farmworker households to be as high as 900 000. The reason given for the large discrepancy in the figures for houses and households has been that more than one household often share a house. Eskom adheres to the figure in the NELF database, and has estimated that about 130 321 (or about 27%) of these houses had been electrified by the end of 1994, with 48 872 of these connected by Eskom (Van der Walt 1995). This can be compared with previous estimates (by Hofmeyr (1994) and Horvei and Dahl (1994) respectively) that approximately 23% of farmworker homes and 15% of farmworker households had been electrified by the middle of 1993.

Depending on which figure is accepted for the total number of farmworker houses in South Africa, their number as a percentage of the total number of houses in rural areas can be either 12% or 22%, while the percentage of electrified farmworker houses can be 15% or 27%. It is therefore important for both policy and planning purposes that the actual number of farmworker households and houses on farmland be established with some degree of accuracy, as this could have implications for the priority which should be given to farmworker electrification, as well as the size of the electrification programme which would be required.

2.2.2 Clinics and schools

Estimates of the numbers of clinics and schools in the country, and the percentage of these which have electricity, vary considerably. Theron (1995a) has estimated that approximately 16 511 (83%) of a total of 19 784 schools¹ and 2 449 (47%) of the 5 212 clinics in South Africa are without electricity at present, although she indicates that these estimates are not accurate. The IDT, on the other hand, has estimated that there are 2 993 existing clinics and health centres nationally at present, of which 1 032 (or 34%) are located in rural areas (i.e. outside of functionally urban areas as defined by the DBSA) (IDT 1995c). It is pointed out that these figures are probably subject to a variation of up to 15%, which would make it more accurate than other estimates. In addition, an estimated 195 'visiting' points for mobile teams, with permanent building structures, exist in rural areas. The IDT has further estimated that about 900 major clinics (mainly in rural areas) and 161 visiting points are currently unelectrified, while about 250 new rural clinics will require electrification (IDT 1995c).

2.3 The electricity distribution industry concerned with rural areas

At present Eskom is the main distribution agency in rural areas, and the only one which operates nationally. It is also the most significant player involved in the electrification of farmers and farmworker households. The other distributors involved in rural electrification in more than a peripheral manner are Durban Electricity, the Venda National Development Corporation: Electricity Department (formerly Venda Electricity Corporation (VEC)) and the Bophuthatswana Electricity Corporation (BECOR). However, their involvement is limited to particular areas. In the case of Durban Electricity this is the greater Durban Functional Region which includes all settlements within a 40 to 50 km radius from Durban, and in some cases beyond that. Parts of the former KwaZulu homeland which fall under the jurisdiction of Tribal Authorities, and are therefore regarded as rural, are also included in this area. VEC and BECOR are only involved in the former homelands of Venda and Bophuthatswana respectively.

Until recently each of the former homelands was served by a separate distributor – in most cases by public utilities, while a few government departments had also been involved (Horvei & Dahl 1994). Most of these are no longer functioning, and Eskom has taken over electrification in these areas. However, in the present uncertain climate regarding supply rights, problems are being experienced in the former Lebowa where electrification workers of the Department of Public Works have tried to prevent Eskom from operating in some areas. Eskom is also not always able to utilise lines owned by the Department.

Although BECOR and VEC are both still functioning, Eskom started with electrification in the former Bophuthatswana in 1994 and is planning to extend its operations to the former Venda in 1996. At present it is working closely with VEC in this area. Both BECOR and VEC will probably be taken over by Eskom in the future.

Supply rights in the former homeland areas will only be finalised during the next few months as part of the process of reviewing and reallocating distribution (as well as transmission and generation) licences nationally. All existing and prospective distributors had to submit applications to the National Electricity Regulator (NER) for the areas in which they wish to supply electricity. Eskom has probably applied for distribution licences in all the 'rural' areas (i.e. outside of municipal boundaries) in the former homelands, and is expected to be allocated rights in most of these areas.

2.4 Off-grid electrification in rural areas

Remote area power supply (RAPS) systems can take a variety of forms, ranging from photovoltaic (PV) systems and wind generators to diesel or petrol generator sets, and combinations of these (i.e. hybrid systems). The supply of these systems in South Africa is almost entirely in the hands of the private sector, and is done through a network of agents and suppliers. It is estimated that 40 000 to 60 000 household PV systems and 2 000 to 4 000 PV water pumps have been installed in South Africa to date, while an estimated 500 to 700 schools and clinics

¹ This figure only includes schools in the former homelands and on commercial farms, as well as schools formerly under the jurisdiction of the 'black' Department of Education and Training.

have been electrified with PV systems (Cowan 1995b). Generally the ability of potential users to pay has determined access to such systems, as the capital costs of PV systems in particular are fairly high.

Eskom introduced a RAPS tariff policy a few years ago, which involved the supply of such systems to customers on the basis that Eskom would finance the systems, and would also be responsible for maintenance and replacements. However, these tariff options have only very rarely been used – in a few installations in the Northern Cape, for example. The factors which contributed to this probably included the high monthly repayments (which included interest, maintenance and replacement charges), as well as a lack of capacity in the regional offices for implementing the policy. It is of interest to note that, although one of the RAPS tariff options was specifically designed for the installation of PV systems at facilities such as remote schools and clinics, it has not been used as part of Eskom's schools and clinics programme (see below).

The most significant programme to date which has made provision for the funding and installation of RAPS systems for community facilities, particularly rural clinics, has been the IDT clinic electrification programme. By the beginning of 1995, 15 clinics in the Northern and Eastern Transvaal had been electrified with PV systems as part of this programme. In addition, current planning provides for an estimated 120 clinics which have been or will be electrified using RAPS systems (including PV systems, gensets and hybrid systems). More recently Eskom's TRI has embarked on a programme to electrify rural schools and clinics using RAPS systems, for which financing is provided by Eskom, and possibly by the RDP fund. These programmes are discussed in chapter 7.

Financing for household RAPS systems is not generally available at present. As discussed in chapter 6, a farmworker electrification programme in the Free State makes provision for the installation of household PV systems which are financed by the Regional Services Councils. Since 1991 a total of 713 houses have been electrified with PV systems as part of this programme. The DMEA has recently embarked on a process of establishing a financing agency for renewable energy systems which is expected to focus initially on the financing of solar home systems. A project to establish pilot projects of solar home systems in rural areas is currently being undertaken by EDRC with the aim to develop and assess different options for the financing and maintenance of systems.

3. The national household grid electrification programme

In this chapter the national grid electrification programme which commenced in the early 1990s will be discussed, including the national targets which have been set, the progress to date, and some of the financial implications.

3.1 National targets

During the deliberations of the National Electrification Forum (NELF) in 1993 and 1994, some scenarios were developed for the implementation of a national household electrification programme which involved the entire distribution industry. The mid-range scenario has been adopted as a set of targets for the distribution industry by Eskom and other distributors, as well as the Reconstruction and Development Programme (RDP) (ANC 1994). However, the way in which these targets were established, is of some concern in light of the absence of a development framework for the electrification programme, as well as an appropriate institutional framework to formulate and implement state policy in this regard. These matters will be returned to in the concluding chapter of this paper.

The proposed annual number of household connections over the next five years are given in Table 2. In 1994 the target was 350 000 new connections, and this builds up to 450 000 in 1996. The targeted annual number of connections starts to decline after the year 2000. Eskom has committed itself to achieving close to 70% of these targets.

	1994	1995	1996	1997	1998	1999
Eskom	250 000	300 000	300 000	300 000	300 000	300 000
Other	100 000	100 000	150 000	150 000	150 000	150 000
Total	350 000	400 000	450 000	450 000	450 000	450 000

TABLE 2: The national electrification targets: domestic connections for 1994-1999

Source: Eskom (1995e)

This rate of connection is expected to raise the level of access to electricity to 67% of the population in the year 2000. At a certain assumed rate of household formation, and the proposed rate of electrification, these targets should lead to an increase in access from 44% of households in 1994 to 65% in 2000 (Theron 1995b). If connections continue at a diminishing annual rate after that (declining to 200 000 per annum in the year 2010), the level of household access should reach approximately 80% by 2012 (Steyn 1994).

It is difficult to assess the proportion of rural households which will be electrified as part of this programme. Theron (1995b) has estimated that the percentage of rural connections made by Eskom has been about 70% in previous years, and is expected to increase to about 80% in 1995 and 90% in 1996. However, if one considers that the rural population might constitute only two-thirds of the population labelled 'rural' in the NELF database², and that functionally urban areas are likely to be electrified at a faster rate than more remote and less densely populated rural areas, it is likely that the actual number of rural connections will be considerably less than 70-90% of the total. Consequently, most of the remaining unelectrified households at the turn of the century are likely to be found in rural areas.

It should further be pointed out that the national targets given above are not seen by Eskom as pertaining to farmworker households (Theron 1995c), so that this group is not expected to benefit significantly from the current electrification programme. This can be contrasted with the recommendations which have been made by Hofmeyr (1994) and Horvei and Dahl (1994)

² According to the DBSA some 65% of households are functionally urban, whereas the NELF database estimates an urbanisation level of only 47%.

concerning the priority which should be given to farmworker households in the light of the relatively low cost of extending the grid to these houses.

3.2 Progress to date

It has not been possible to obtain electrification figures from all the distributors involved in the national electrification programme. Table 3 gives the numbers of connections which have been made since the inception of the programme to the middle of 1995, as reported by Eskom. These figures include connections made by Eskom and other distributors before the national targets were established³. The information presented in the table reflects the different ways in which Eskom has been involved in the national programme. In addition to the direct connections made by Eskom, the utility has also provided incentives to farmers and other distributors to increase the rate of electrification. The incentive scheme aimed at farmers is discussed in chapter 6. The scheme aimed at other distributors either took the form of a once-off contribution of R400 by Eskom for each new connection made, or a bulk purchase discount for the additional sales through these new connections (Engelbrecht 1994). However, this scheme has recently been discontinued.

Type of connections	1991 & 1992	1993	1994	Inception to Dec 1994	1995 to mid-year	Total (inception to 6/1995)
Eskom direct connections ¹	176 557	208 801	254 363	639 721	128 182	767 903
Farmworker connections	12 698	16 074	16 838	45 610	8 505	54 115
Incentive connections	22 622	69 756	106 950	199 328	31 446	230 774
Total	211 877	294 631	378 171	884 232	168 133	1 052 812
Total capital expenditure	R472m	R584m	R808m	R1 864m	R385m	R2 250m
Capex per connection (R)	R3 036	R2 799	R3 176	R3 070	R3 004	R3 070

1 Excludes take-overs by Eskom

TABLE 3: Progress with national electrification programme at June 1995
Source: Eskom (1995e) and du Plessis (1995)

Total capital expenditure by Eskom to date has been R2.25 billion (Eskom 1995g). The cost of the incentives schemes totalled R39 million during 1994, 77% of which was accounted for by direct contributions towards capital expenditure (Eskom 1995h). The remaining was due to incentive schemes on farmworker houses (R4.7 million) and bulk discounts to municipal distributors (R4.6 million) (Eskom 1995h). The numbers of direct connections which have been made by Eskom in the different distributor areas as part of the current electrification programme, are presented in Table 4.

If it is assumed that approximately 70% of the connections made by Eskom from 1990 to 1994 have been in rural areas (Theron 1995b), the number of rural connections made during this time would amount to about 447 500. This constitutes about 11% of the total number of houses in rural areas as indicated in the NELF database (see Table 1). By comparison, an estimated 45 600 farmworker houses have been connected by Eskom during this time (see Table 3).

³ Both Eskom and Durban Electricity (DE) embarked on large-scale electrification programmes before the national targets had been set: Eskom towards the end of 1990, and DE in late 1991. Eskom has since increased the number of connections it has made annually in accordance with the increased targets agreed on in the NELF.

Former distributor	1990/91	1992	1993	1994	Inception to Dec 1994	1995 to mid-year	Total (inception to June 1995)
Bloemfontein	2 628	26 425	41 711	44 338	115 102	17 715	132 817
Cape Town	3 149	14 470	23 381	47 223	88 223	18 773	106 996
Durban	17 165	41 027	42 703	43 851	144 746	20 860	165 606
Johannesburg	2 229	28 508	45 954	45 814	122 505	20 487	142 992
Pretoria	5 417	35 092	55 052	73 137	168 698	50 347	219 045
Total	30 588	145 522	208 801	254 363	639 274	128 182	767 456

TABLE 4: Number of direct connections made by Eskom from 1990 to June 1995.

Source: Eskom database

3.3 The financing of the programme

In this section the financing of the national electrification programme will be discussed: the projected financing requirements, and the strategies employed to raise finance for electrification.

3.3.1 Capital and financing requirements for electrification

There are different ways of investigating the financial impact of the electrification programme. Firstly, there are the capital costs required to implement the programme. Secondly, there is an investment analysis which attempts to evaluate the net present value of the programme, taking into account all costs and revenues, but irrespective of financing considerations. Thirdly, there are the financing requirements, which look at the annual cash flows, and takes into consideration capital expenditure, depreciation, operating costs and revenues, cross-subsidies and financing.

There have been three attempts to investigate the financial impact of the electrification programme: NEES (1993), which investigated three electrification scenarios; van Horen (1994), who investigated a 'business-as-usual' scenario and an 'IEP' scenario; and Els (1994), who looked at the plan proposed by the RDP. In terms of connection rates, van Horen's IEP scenario, the NEES scenario two and Els' scenario are all similar - a peak of 450000 connections per year. However, each of these three studies have differed in some of the other underlying assumptions, as well as methodology employed.

All three studies reach similar conclusions regarding the capital requirements of the programme. The NEES scenarios looked at the years 1993 to 2010 and concluded that the capital expenditure would be in the order of R28 billion (1993 terms). Van Horen calculated that the total capital requirement over the slightly shorter period 1994 to 2010 would be in the order of R22 billion (1993 terms). The difference is partly due to a shorter time period, but also because the NEES analysis had a higher average cost per connection, and also included high expenditure on unelectrified rural farms in the middle of the programme. Els looked at the longest period: 1992 to 2012 and arrived at a total capital requirement of R23.2 billion, in 1994 terms. These totals correspond to an annual capital requirement of R1.2 to R1.5 billion, of which approximately R1 billion will be spent by Eskom (van Horen 1995).

Differences arise between the studies in the estimation of the operating costs and consequent financial impact of the electrification programme. Els points out that a distinction should also be made between embedded costs and incremental costs. If the costs of electrification are to be based on embedded costs, then this means that new consumers are expected to pay for their portion of previously installed infrastructure. If costs are based on incremental costs, then new consumers are only required to pay for the additional costs which they impose on the system. In the case where surplus capacity exists (for example in generation or transmission infrastructure), then the financing requirement based on embedded costs would be higher than that based on incremental costs. Els opted to use embedded costs in the calculations. Although the other two studies did not make this explicit, it appears that they used lower incremental costs.

A second distinction should also be made between historic and current costs. This affects pricing policy in that tariffs are calculated to recover current investment costs, i.e. they are calculated to escalate with inflation so that revenues are sufficient to replace ageing equipment. However, if figures are expressed in fixed prices, this consideration should not affect the result.

The conclusion of the NEES analysis and van Horen's study is that operating losses are small in comparison to capital costs, and that operating losses turn into surpluses after approximately 10 years. The NEES analysis concluded that total annual cash flows would not turn positive over the duration considered and that the cumulative cashflow after 20 years would be negative R28 billion. Van Horen arrived at a similar result, concluding that the cumulative cash flow would be negative R22.4 billion. Els' study arrives at a different result: that the cumulative cash flow would be negative R70 billion - two to three times greater than that estimated by van Horen and NEES.

Van Horen has estimated that cumulative operating losses to date have amounted to more than R300 million. Theron (1995b) has also shown that the operating loss to Eskom is in the region of R20 per month for each newly electrified customer. If finance charges are included (assuming that all losses and capital expenditure are covered by debt), the loss increases to R60 per customer per month (Theron 1995b)⁴. Clearly, interest charges have the effect of dramatically increasing the operating loss. However, it is equally clear that Eskom and other distributors are using cross-subsidies from other consumers and debt is only used to cover a portion of costs.

	NEES	Van Horen	Els
Base year	1993	1993	1994
Cost per connection ¹	R4 000	R3 500	R3 800
Bulk supply cost	9.5c/kWh	11.2c/kWh	16.2c/kWh ²
Support cost	R15-R20/mth	R20/mth	R15-R23/mth
Refurbishment	incl. in bulk supply cost	2% of capex p.a.	20% at yr 10; 50% at yr 20
Consumption ³	150 - 450 kWh/mth	150 - 450 kWh	150 - 450 kWh/mth
Tariffs	18c/kWh	20c/kWh	22c/kWh ²
Losses	20%	12%	20%
Real discount rate	4%	3%	6%
Electrification 'levy'	n/a	4%	5%
Capital investment	R28 bn	R22 bn	R23.2 bn
Cumulative cash flow	- R28 bn	- R22.4 bn	- R70 bn
Cum. c.f. after levy	n/a	- R9.2 bn	- R3.4 bn
NPV	- R19.4 bn	- R18 bn ⁴	- R11.7 bn

1 This varies for house type, region and time. Averages are presented.

2 Declining by 6% real in year 1, 6% in year 2, 1% in year 3 and 1% in year 4.

3 Consumption is different for each consumer category and varies with time.

4 Calculated from cash flows presented by van Horen.

TABLE 5: Essential assumptions and results for three studies

The differences are caused by a number of factors. Essential assumptions from the three studies are presented in Table 5. Although support costs, losses, and consumption rates are roughly similar, there are important differences regarding supply costs, refurbishment and tariffs. Els assumed a higher bulk supply cost, in keeping with his policy of using embedded rather than incremental costs. Els also assumed real tariff decreases (13% over four years) in

⁴ These losses are expected to decrease as consumption increases.

keeping with Eskom's pricing compact. It is also apparent that Els included finance charges in calculating the annual cash flow - which was not done in the other two studies. These factors together account for the different results.

The negative cash-flows experienced in the electrification programme are not all financed by borrowings. Cross-subsidies from higher consuming customers are also used. Els looked at the effect of using cross-subsidies to cover annual operating losses and found that these were equivalent to levy of approximately 5% of other electricity sales. These cross-subsidies dramatically reduced financing requirements to R3.4 billion over 20 years. Van Horen looked at the impact of a 4% levy on electricity generation and found that this reduced the peak cumulative financing requirement to R9.2 billion. Again there appears to be some discrepancy here between the two studies.

Only Els' report separated Eskom's costs from those experienced by other distributors and found that Eskom would bear approximately 75% of capital costs, cross-subsidies and financing requirements. Els concluded that although this appeared achievable for Eskom, there were doubts concerning the ability of non-Eskom distributors to raise both the necessary finance and cross-subsidies.

3.3.2 Eskom's financing strategies

Given that Eskom is in a better position to utilise cross-subsidies and raise finance from the capital and money markets, Eskom's financing options will be discussed separately from those of municipalities. Potgeiter (1994) estimates that Eskom needs to raise between R2 billion and R3.5 billion per annum from the domestic and foreign financial markets (for all financing requirements, of which electrification is only a part). This requirement includes the servicing of existing debt and the repayment of maturing debt. In 1994 the total interest and finance charges were R3.2 billion (Eskom 1995g).

The principle finance mechanisms used by Eskom are long term (more than three years) fixed interest bonds. The most popular such bond, which in 1992 was established as a financial benchmark in South Africa, is the E168 with an 11% coupon that matures in 2008. In addition to bond issues, short term liquidity is ensured through the use of a Commercial Paper Bill, with maturities of up to 12 months. A special instrument, issued in May 1993, was the Electrification Participation Note (EPN1) which is a linked instrument with two components - a fixed interest rate of 6%; and a warrant component where the return is linked to revenue from the electrification programme. The EPN has a floor of 80% of the E168 at time of issue. The 1993 EPN1 issue raised R540 million at a projected rate of 14.66% (compared to 15% on the E168). EPN1 was subsequently replaced with EPN2 which raised R1.2 billion (Eskom 1995g).

Eskom has also recently investigated the use of concessionary loans from the DBSA, specifically to finance electrification projects. However, these loans are likely to be a relatively small portion of the total finance requirement.

The domestic capital market is estimated to be able to provide approximately R1 billion of Eskom's requirements via conventional bond issues (Potgeiter 1994). Potgeiter (1994) estimates that balance can be sourced from special instruments such as the EPN, foreign markets, or concessionary sources. To facilitate Eskom's re-entry into international capital markets, credit ratings were obtained from Moody's Investor Services and Stanley and Poors Rating Group. Ratings were the same as awarded for the country as a whole (Eskom 1995g).

Raising finance for the electrification programme should be seen in the context of Eskom's other capital investment projects (principally the Majuba power station), and the target of improving Eskom's debt to equity ratio. It should be noted that Eskom is increasingly financing capital expenditure from its own cash flows. The total capital expenditure during 1994 was R4.2 billion, partly made up of expenditure on Majuba power station (R867 million) and the electrification programme (R808 million). Net income for the year amounted to R2.2 billion, and was used to build up reserves. Eskom's debt to equity ratio has been steadily improving from 3.0 in 1986 to 1.7 in 1994. The target is to reduce this ratio to parity by 1997.

3.3.3 *Non-Eskom financing*

The financing of non-Eskom electrification remains one of the most significant obstacles facing the successful implementation of the electrification programme. The work by Els (1995) indicates that the total financing requirements of non-Eskom distributors (including finance charges) is in the order of R13 billion. The ability of these distributors to cover this, either through cross-subsidies or from other sources, has been questioned.

Many Transitional Local Councils (TLC's) are applying for licences to supply their areas, and are submitting electrification plans as part of this application. Only after the licensing round is complete will it be possible to accurately determine the size and nature of the financing requirements facing TLC's electricity departments.

Durban Electricity is the largest municipal distributor in the country and has embarked on its own electrification programme. Financing for this has been obtained from three sources: (1) DBSA loans have been used to pay for a large portion of the capital; (2) Durban Electricity's own capital fund, built up from surpluses, has also been used to raise capital; and (3) a 'working capital' fund has been used to cover operational losses (Whitehead 1995). Other municipal distributors, which smaller customer bases, are in a weaker position to raise finance.

3.3.4 *Grant funding*

At present grant funds are available for the electrification of schools and clinics. However, a number of Eskom documents refer to the possibility of government financial support for household electrification (Els 1995; Theron 1995b). In contrast to this, the government has stated that the electrification programme must be financed by the electricity supply industry itself. Eskom has set a cap of R4 000 per rural connection and has stated that it will only embark on more expensive projects where 'a capital contribution equal to the uneconomic portion is received from an external source' (Theron 1995b).

Given the current government policy of not financially supporting household electrification, it is not clear where such grants may come from. However, there are precedents of external funding having been used to reduce the capital cost. In the past it was not uncommon for Eskom to receive contributions from erstwhile government structures - the Regional Services Councils, Provincial Administrations and House of Representatives. In the former homelands there were incidences of homeland government funds being used to finance grid extension as well as subsidising the cost of supply. However, the possibility of continued state support for electrification is by no means certain. Although some foreign aid may be available for the energy sector, it is likely to be targeted at the electrification of community facilities, not household electrification.

4. Eskom's household grid electrification programme

As discussed above, Eskom is currently involved in a major electrification programme which appears to focus increasingly on more rural areas. This programme will be discussed here in great depth, focusing particularly on two areas: current experience regarding consumption rates, costs and losses in the programme, and the approach to planning and consultation with stakeholders which have been followed in the programme.

4.1 The approach to electrification

Eskom's tariff policies are discussed in great detail in Appendix A. Generally households which are connected as part of the current electrification programme, pay the Homelight 1 tariff. This involves a nominal connection fee and an energy charge - currently set at R45 and 25.81c/kWh (inclusive of value-added tax (VAT)) respectively - with no fixed monthly charge. The approach taken is to connect all houses in an area which is electrified, because of the high cost of 'fill-in' connections, and no applications are therefore required. The connection fee is then collected at the first purchase of an electricity token.

Electrification is generally done in accordance with Eskom's current electrification standard, irrespective of the nature of the area which is electrified. However, some pilot projects are underway to test lower cost technology options, particularly with the aim to reduce the costs of electrification in rural areas (see below). Reticulation is done overhead, but provision is made for underground connection cables if this is requested by the communities concerned⁵. Houses are generally provided with a 60 A supply, or alternatively a 40 A supply, and ready-boards are provided if houses have not been wired. Metering is generally done using prepayment meters rather than conventional credit meters.

Public lighting is generally not installed in rural settlements where there are no local authorities able to pay the installation, maintenance and operating costs (see Appendix A).

4.2 The experience to date: consumption, costs and losses

One of the main problems experienced by Eskom has been the high cost of electrification and the high distribution losses which have been incurred in the face of consistently low consumption rates. These problems, and the strategies which have been put into place to address these, will be discussed in this section.

4.2.1 Electricity consumption rates

As indicated in Table 6, consumption levels amongst newly electrified households, measured in terms of recorded sales, are generally low. For all Eskom's prepayment customers in the country, average sales during 1994 were 80 kWh/month. There was some regional variation with the highest consumption (123 kWh/month) found in the Cape Town distributor area, and the lowest (55 kWh/month) in the Pretoria distributor area, which is regarded as the most rural in nature of all the former distributors. It is also the area where the greatest number of connections have been made since the inception of the electrification programme.

⁵ In such cases the local people have to dig the trenches for the cables themselves at no cost to the project (Kinnear 1995).

	Connections	Capex (R'000)	Cost per connection	Average sales (kWh/month)	Support (R/month)
Bloemfontein	44 338	121 035	2 730	79	21
Cape Town	47 243	140 216	2 968	123	18
Durban	43 851	214 421	4 890	88	18
Johannesburg	45 814	89 337	1 950	67	32
Pretoria	73 137	242 983	3 322	55	28
Total	254 383	807 992	3 176	80	26

TABLE 6: Breakdown of 1994 costs and sales in the Eskom distributor areas*Source: Eskom (1995g)*

Viljoen and Kidgell (1994) analysed the electricity consumption of 20 settlements in the former Pretoria distributor area which are regarded as rural, and had been electrified at different times during the last few years. They found that average household 'implied' consumption, as reflected by sales, varied between 20 and 80 kWh/month for different settlements, although it was clear that some consumers used substantially more electricity than was purchased (see below). The average 'implied' consumption per household (calculated for eight of the settlements which spanned the range of consumption rates) was found to be 31.1 kWh/month, while the median was approximately 12.5 kWh/month. Approximately 13% of the connected households in this sample did not purchase any electricity, while another 12% purchased less than 5 kWh/month, and only 25% purchased more than 35.5 kWh/month. This analysis clearly has limitations, but it gives an indication of the current situation regarding consumption patterns, or rather purchasing patterns, in some rural settlements.

Consumption is generally expected to grow during the first few years of access to electricity, and to reach a plateau after a few years. For example, in the financial modelling of the electrification programme done by Els (1994), he assumed that consumption rates would start at 60 and 80 kWh/month for different categories of rural settlements, and increase at 20% per annum, reaching a maximum of 150 and 200 kWh/month respectively after 7 years. Little information is available on actual consumption growth in newly electrified settlements in South Africa, although reports from the Eskom sales database indicate that consumption does appear to increase with the time since connection (Eskom 1994b).

Eskom's strategy to increase consumption generally focuses on the marketing of electrification, in the case of Homelight customers, through its Elektrowise department. Strategies to improve access to appliances have also been put in place – for example, in the Northern Transvaal local businesses are contracted by a supplier to sell a range of appliances in rural settlements (Potgieter 1995). Financing packages for the purchasing of appliances are also provided. It has also been found that improving access to vending outlets for electricity tokens or cards, can make a major contribution to consumption levels. For example, in one settlement in the Eastern Transvaal consumption had reportedly doubled when vendors were made more accessible both with respect to distance and times of operation (Mocke 1995).

The strategy of increasing consumption is, however, not always in line with strategies to reduce supply costs, for example, by reducing the system peak load (see below). In some cases it might therefore be desirable to contain the demand for electricity.

4.2.2 Distribution losses

Losses in the distribution and transmission systems are currently very high, with some distributor personnel estimating these to be as high as 40% or 60% (these figures could not be confirmed). Since rural electrification projects require long transmission lines with low loads, technical losses can be expected to be relatively high. However, only a 10-15% loss can be attributed to these causes, the remainder being due to meter failures, theft (through the bypassing of prepayment meters) or non-payment (in the case of conventional metering systems).

Some problems are still being experienced with faulty meters, although most of the initial problems with this technology seem to have been addressed. Theft through the bypassing and tampering with prepayment meters seems to be the greatest problem at present, and is particularly prevalent in urban areas. It appears that by comparison, losses from theft in rural areas are still relatively low.

Eskom has begun to implement loss control exercises. This requires that bulk meters be installed at the supply points to settlements. Sales are then compared with actual consumption, and in areas where a significant discrepancy exists (more than 10% loss), the sales records are examined. Customers who do not appear to purchase electricity are visited, and if the meter has been bypassed they are disconnected. A fee of R500 is payable for reconnection (Brown 1995). Experience is that most households pay the reconnection fee promptly. In KwaZulu-Natal this system has only been in operation for four months and the effects are not yet discernible. Where losses are exceptionally high, it is felt that this system is likely to be inadequate as the problem cannot be attributed to a limited number of offenders. In these cases a process of community consultation is initiated in the hope that this will help solve the problem (Brown 1995).

Other loss control options being examined include new meter designs. Meter boxes which are harder to violate are being developed, as well as a system where only the card reader is situated inside the customer's house. The bulk of the control and electronic equipment is situated on the pole, making tampering more difficult.

4.2.3 The costs of electrification

4.2.3.1 Capital costs

From Table 6 it is evident that the capital cost per connection, which depends on settlement patterns, topography and the extent of existing infrastructure, varies significantly between different regions. During 1994 the average cost for all electrification conducted by Eskom was R3 179 per connection. Capital costs were lowest in the area served by the former Johannesburg distributor where the bulk of connections were made in higher density urban areas, while costs were significantly higher in the Durban distributor area which deals with difficult topographical conditions in KwaZulu-Natal. The average connection costs in the Durban area are in fact higher than the maximum of R4 000 which have been set for rural areas (R2 500 in urban areas).

As the rural component of Eskom's electrification programme grows, costs are expected to increase correspondingly. However, Eskom has set itself the target of reducing the average capital costs per connection by 30% (i.e. to R2 180 in 1995 terms) by the year 2000, mainly through the use of innovative technologies and the introduction of new technical standards (Roux 1995). Eskom's Distribution Technology department has been charged with investigating the opportunities for cost reduction, to culminate in the issue of a new rural electrification standard. Specific options for cost reduction include the use of new technologies on MV and LV lines, easing of temperature sensitivity specifications, an increase in loss allowance to 10%, lower steel content conductors, longer spans, the more extensive use of unfirm supply, intermediate voltage systems and the use of current limiters in the place of prepayment meters. A range of pilot projects to test some of the more promising options are being implemented by Eskom (Roux 1995).

A move away from standard three-phase designs also holds cost reduction possibilities – for example the use of single-phase phase-to-phase and phase-to-neutral systems (Wyatt & Dingley 1995).

While it appears that the cost reduction target set by Eskom may be achieved, there are concerns that the distribution systems built over the next five years will have to be strengthened in the future in order to meet demand from existing and future connections, at considerable cost (Roux 1995). If short-term cost reduction strategies mean that longer-term cost optimisation is compromised, this may have serious implications for the continuation of the electrification programme after the year 2000.

4.2.3.2 Operating costs

Operating costs comprise supply costs as well as support costs. The latter is related to the services provided to users of electricity. It includes all overheads on a pro-rata basis as well as direct costs attributable to a customer (billing, vending, maintenance, etc.). At present these costs for electrification projects vary between R18 and R32 per customer per month for the different Eskom distributors, with a national average of R26 (see Table 6). Support costs are generally thought to be higher in rural areas than in urban areas, for reasons such as the longer distances and lower population densities involved, as well as difficult terrain in some areas (such as KwaZulu-Natal). However, contrary to expectations, support costs in the highly urbanised Johannesburg distributor area are the highest in the country. Apparently a recent comparative study between a rural and urban settlement has found service costs to be higher in the urban area. One reason which has been suggested is that urban customers expect a quicker response to problems than rural customers (Schoeman 1995b). It should be noted, however, that service costs are also relatively high in the Pretoria distributor area which is regarded as fairly 'rural' in nature.

Eskom's target is to reduce the average support cost to R15 (in 1995 terms) per customer per month over the next few years – a real reduction of 40% (Schoeman 1995b). In remote rural areas one possible strategy to achieve this is to contract a local agency to perform functions such as vending or revenue collection, education, first-line maintenance and post-electrification connections. Pilot projects in which such arrangements are to be developed and tested, will be implemented in the near future.

Supply expenses consist of the cost to generate and transmit electricity, and the cost of maintaining the generation and transmission facilities. A number of factors affect the estimation of these costs. Firstly, since a portion of the generation and transmission costs are related to the maximum demand, the load at peak times will directly affect costs. Secondly, the distance from the main generating stations will also affect costs. This is partly due to transmission losses, and partly due to the additional cost of maintaining and upgrading the transmission system. In the third place, the costing time horizon will also affect cost estimations. The short-run marginal cost refers to the costs of supplying an additional unit of electricity using existing generation equipment. The long-run marginal cost refers to the cost of supplying additional electricity, taking into account the need to increase generation and transmission capacity due to the increased load. If a utility has excess capacity, the long-run cost will be significantly higher than the short-run cost. This is reflected in Eskom's estimation of increasing marginal cost over the next ten years (Davis & Horvei 1995). Lastly, the cost of capital will affect a utility's debt servicing. Although Eskom has traditionally been able to raise capital cheaply, this can not be said of other distributors. As investment in electrification increases, it is possible that investors may force rates up in response to this increase risk exposure.

Domestic customers tend to have relatively low load factors (Els (1994) used a load factor of 34% based on newly electrified - presumably urban - communities) and hence a relatively high cost of supply. It is likely that even lower load factors will be experienced in rural areas, where the mix of residential and commercial consumers is likely to be less diverse. One of the important effects of expanding the residential customer base in the country is the effect on the system peak, which presently corresponds to the residential peak demand. The contribution to the peak from newly electrified residential customers is presently only around 5% of the total (Eskom 1995c). However, as the electrification programme expands, this contribution could increase significantly.

The viability of electrification projects will depend very much on the nature of consumption and the mix of consumers. In Zimbabwe efforts have been made to identify rural 'growth points', not only to maximise the impact of electrification, but also to electrify places where the consumer base will be more diverse and so consumption and load factors higher (Robinson 1991). The use of thermal loads in households, such as stoves and heaters, may increase electricity consumption, but they also increase the peak demand and so increase supply costs.

Opportunities to reduce supply costs lie in improving the load factor on the system, primarily through demand side management strategies. For Homelight consumers, Eskom's principle

strategy is to limit the current available for low consumption loads. This effectively limits the maximum demand that a user can place on the system and should have a role in constraining the ADMD (after-diversity-maximum-demand) and so in improving the load factor. The current aim is for about 85 000 of the connections that will be made in 1996 to be done using low-cost technologies and current limiters (Mocke 1995). The use of 2.5A current limiters in remote areas, coupled with a flat-rate tariff, is thus being investigated in a number of pilot projects. Such an approach should contribute to a reduction in both capital costs and operating costs, since the use of prepayment meters as well as the need for vending systems would fall away (although some alternative system for revenue collection will be required).

However, as mentioned above, the use of this strategy will put a ceiling on consumption growth, and is therefore contrary to Eskom's current sales drive. A different approach will therefore be required in areas where such systems are introduced. The approach envisaged by Eskom includes a strong emphasis on education to enable consumers to make best use of the available supply, as well as possible involvement in improving the provision of alternative energy supplies in the areas concerned (Patrick 1995).

4.3 Electrification planning

Electrification planning in Eskom will be discussed here, particularly insofar as it pertains to rural areas. Planning processes have been evolving continually since the onset of the electrification programme, as the organisation grew in experience, and with the recent dramatic changes in government policy and the nature of government institutions. There has also been substantial variation in the way planning has been done in different regions, because of the widely differing conditions under which Eskom operates. Planning processes were recently reviewed by an internal working group, which made some recommendations, one of the main ones being the introduction of a standardised planning process in the organisation. This is currently being implemented, and the aim is to have it in place by the end of 1995 (Mocke 1995). In addition, Eskom's policy on 'stakeholder consultation' (see below) which has formed an important part of the planning processes, has also recently been reviewed.

It is important to note that no institutional framework currently exists to facilitate national electrification planning for the distribution sector as a whole. The responsibility for electrification planning therefore still lies with specific distributors. Eskom in particular, being a public utility and responsible for more than two thirds of the national electrification programme, is planning and conducting what is in fact a government-sanctioned and highly subsidised national electrification programme, virtually on its own. The utility has itself indicated that it expects of the government to provide a framework for electrification planning (Theron 1994).

4.3.1 The organisation of electrification planning in Eskom

The way electrification planning is organised in Eskom has recently been changed, as part of the restructuring of its distribution business. In the past electrification planning was conducted at distributor level by small planning units headed by the electrification managers of the former distributors. The national electrification planning manager at Eskom's head office was responsible for the co-ordination of planning nationally. Each distributor was set annual targets through an iterative process between the distributor and head office, and it was the responsibility of the electrification managers in the distributors to achieve these targets.

As part of the recent restructuring, electrification planning has effectively been centralised within the Electrification/Engineering division. National electrification planning is now the responsibility of a planning unit headed by the national electrification planning manager at Eskom's head office. Electrification targets are set for each Sales and Customer Service (SACS) area, and the electrification manager in each SACS area is responsible for achieving these targets. In addition, four area electrification planning managers are to be appointed which will report to the capital projects manager at Eskom's head office (Steyn 1995). However, electrification planning is not a line function. The SACS electrification managers still form part of SACS structures, and special provision has been made for the managing of electrification

targets by means of compacts which have been negotiated between SACS electrification managers and the national electrification planning manager (Theron 1995c).

This functional centralisation of electrification planning is seen as a short-term arrangement with the aim of establishing appropriate planning procedures and systems for the current electrification programme, while the long-term aim is to integrate electrification planning with the ongoing business of the SACS offices (Theron 1995c).

4.3.2 Macro-level planning

The way Eskom is currently approaching electrification planning has been outlined by Theron (1994; 1995b). Macro-level planning is being conducted for both 20-year and five-year periods. Long-term 20-year electrification planning entails a review of the financial and resource implications of feasible electrification scenarios (Theron 1995b). Five-year planning is conducted annually, and involves setting targets and compiling budgets per province, and in some cases for sub-regions within larger provinces. These targets are set in consultation with national and provincial stakeholders, of which the RDP structures and government departments at national and provincial levels are of particular importance. However, the details of how this is done at present are not clear.

Five-year planning also involves the development of a masterplan for each region. The degree to which this has been done in the past has varied considerably, particularly as concerns rural areas (Mocke 1995). In the majority of regions some degree of formal planning has been conducted by Eskom at a regional level, using available information on existing networks and their capacity, and the location and demographics of settlements. The approach in most areas has been to incrementally expand the grid, electrifying communities on a least capital-cost basis (Brown 1995). The plans devised in this way were submitted to electrification forums (see below) which represented a range of interests at the regional level, where these existed. In most cases this was for the purpose of informing organisations involved of Eskom's plans, rather than to conduct negotiations concerning the plans (Eskom 1994a).

In two regions, the former homelands of Lebowa and Gazankulu, the opposite approach was taken – that is, electrification forums compiled priority lists of settlements in each district to be electrified over a five-year period (Potgieter 1995). One of the reasons for this approach seems to have been the lack of reliable information on the electricity network in these areas, particularly the former Lebowa. The lists had to be modified through negotiations between Eskom and the forums, taking into consideration the number of connections which had been allocated to each district. In some areas the lists were accepted by Eskom with only minor changes, such as the rolling over of additional connections to following years (Potgieter 1995), while in other areas settlements which had been identified as 'non-viable' were removed and replaced by others (Seymour 1995). As the plans which were compiled through this process did not take the existing network into consideration to any significant degree, settlements closer to the grid were often bypassed in favour of others at a greater distance, which were on the lists. In at least one case a substation belonging to the former Lebowa Department of Public Works had to be upgraded at short notice, as it did not have sufficient capacity to allow the electrification of a particular settlement (Potgieter 1995). As a result of these factors, the capital costs of projects have probably been higher than they could have been if a different approach had been taken.

As mentioned earlier, a standardised planning process is currently being implemented in the organisation. This process attempts to address these problems and thus reflects the current emphasis on reducing the costs of electrification. The most significant aspect of the new process is that, as a first step, Eskom will develop least-cost electrification plans up to a subregional level, based on technical and financial considerations, such as the constraints on capital expenditure (see for discussion on costs earlier) (Theron 1995c). These plans will form the basis of any negotiations with stakeholder bodies. It will include alternatives which are available in particular areas, within the set financial and technical constraints. In order to facilitate decision-making on the areas to be electrified in cases where alternatives exist, the potential economic impact of electrification in different areas will be evaluated by Eskom (Theron 1995c).

The main constraint facing Eskom in the implementation of this process, is the lack of adequate demand- and supply-side information at present, particularly concerning rural areas. Eskom currently uses the housing and demographic database developed originally for the National Electrification Forum (NELF) for planning purposes. This will be replaced by the Housing and Electrification Planning (HELP) database which is to be developed over the next few years in co-operation with other sectors (Du Toit 1995). In addition to limited demographic and settlement data, information on electrification networks in some of the former homelands where Eskom has only recently become involved (such as the former Lebowa) is not readily available. Another problem is the fact that new local government boundaries will need to be used for planning in the future, while available information is generally organised in terms of magisterial districts, which are currently used by Eskom as the primary planning unit.

4.3.3 Micro-level planning

Micro-level planning is concerned with particular projects, and is closely linked to the Distribution Business Capital Investment Process (Theron 1995b). In the past, two-year and one-year plans have been compiled annually, drawing on five-year plans where these were available, as well as consultation with stakeholders where such structures were in place. Recently the concept of 'moving planning windows' has been introduced. Two-year plans are now updated and approved by Eskom's Capital Investment Committee (CIC) on a quarterly basis, using a 24-month moving window – that is, every three months the projects planned for the last quarter of the next two years are reviewed (Theron 1995b). One-year plans are also updated and the capital investment approved by the CIC on a quarterly basis, using a 12-month moving window.

Although it is widely acknowledged that projects in low income areas (both urban and rural) are unlikely to be financially viable, Eskom's head office requires that each project proposal passes a financial rate of return criterion (presently set at 6% real per annum over 15 years). It is now also required that a cost-benefit analysis must be conducted on each project, and the criterion is to obtain a 8% real economic return (Matlhare 1995). These guidelines have not been strictly applied, however, as the pressure of ambitious targets and the time required to successfully negotiate plans with local communities have often meant that any project which can be implemented with minimum delay was automatically selected.

Information used in the financial and economic analyses on rural settlements has generally been unreliable, as it has been based on rough estimates rather than actual surveys, and could therefore not be verified in any way. For example, information on settlements which are to be electrified may be obtained from Tribal Authorities and/or through brief interviews with a limited number of residents (Potgieter 1995; Seymour 1995). Pre-electrification research has generally not been performed in rural settlements. Eskom has recently launched a number of initiatives to improve demand-side information required for planning as well as marketing purposes, such as the development of the HELP database, and the national panel survey conducted by the marketing division (Liebenberg 1995).

An initiative is also underway to assist with the identification of settlements where the proposed load-limited supply options could be implemented (see for earlier discussion on costs of electrification) (Mocke 1995).

4.4 Consultation with stakeholders

Consultation with what has been broadly defined as 'stakeholders' in electrification has been a feature of Eskom's planning processes for a number of years. In this section the way in which this policy has been implemented to date, problems which have been experienced, and recent changes to the policy will be discussed.

4.4.1 The history and current situation

Consultation with stakeholders has generally taken place within forums which differ significantly with respect to composition, functioning and activities. In 1994 regional electrification forums existed in the former homelands of Lebowa, Gazankulu, KwaNdebele and Transkei, as well as in the Free State, Border/Kei, Eastern Cape, Western Cape and

KwaZulu/Natal regions (Eskom 1994a). The establishment of most of these forums had been initiated and facilitated by Eskom. In some cases these structures were linked to regional economic forums (as in KwaZulu-Natal, Free State and KwaNdebele). The most significant players involved in these forums were Eskom, municipalities, regional civic bodies, government structures, development agencies (for example, non-governmental organisations and community-based organisations), traditional leaders, political organisations, trade unions and organised business. Their activities were mainly restricted to information sharing (on, for example, Eskom's plans), as well as discussion on matters such as NELF proceedings, developments in local government and the non-payment crisis in townships. It thus appears that most of these forums were concerned mainly with electrification in urban areas.

The two main exceptions to this seem to have been the regional forums operating in the former homelands of Lebowa and Gazankulu respectively: the Lebowa Electricity Advisory Committee and the Gazankulu Electricity Advisory Committee. In both these areas subregional forums existed at the level of the magisterial district, which were represented on the regional forums. As a result the impression was created that these forums were 'much more representative of all the communities within the region' (Eskom 1994a). However, no local forums existed in these regions, and the subregional forum in each district also took responsibility at the project level for liaison with the communities concerned and organising implementation. Furthermore, in the absence of municipalities, Tribal Authorities, the only form of local government which existed in these areas, played the most important role in decision-making on these forums (Eskom 1994a). It is also of interest that these seem to have been the only forums in the country which dealt with the prioritisation of electrification projects as a central part of their activities, as discussed before.

It has become evident that a number of problems have been experienced with these forums (Sterley 1995; Potgieter 1995). The legitimacy of the forums has been in dispute, and their decisions concerning the prioritisation of projects have often been questioned by other parties in these areas. In addition, it appears that some of the members of the forums were mainly interested in ensuring that their particular places of residence were electrified, and thus became inactive once this had happened. When such a person was replaced by another, it often meant that the priority list of projects had to be revised to include his place of residence. A further problem which has been experienced is that the forums expected Eskom to divide the number of connections amongst a large number of settlements, rather than to electrify a smaller number of settlements completely. These circumstances have given rise to conflict, making planning difficult.

At present the situation with regard to electrification forums is in flux. By the beginning of 1995 the regional electrification forums in the Western Cape and the Free State had been disbanded, while attempts were being made to integrate the separate regional electrification forums in the Northern Province and the Eastern Cape Province, and to extend the forum in KwaNdebele to a provincial forum (Lithole 1995). However, with the political and institutional changes of the last year, including the establishment of RDP structures in some areas, and the imminent establishment of local government structures in rural areas, it seems that most of the current forums are in demise.

4.4.2 Recent developments

Eskom's consultation policy has been reviewed during the last year in the light of the problems which have been experienced as well as the recent political and institutional changes in the country. A number of recommendations concerning the structure and functions of electrification forums have been made previously (Eskom 1994a), and more recently further recommendations have been made about the establishment and role of consultation forums (Theron 1995c). The most significant changes which have been proposed are the following:

1. Eskom will no longer take responsibility for the establishment of electrification forums. In areas where official collective forums have been established, for example by the provincial RDP offices, these forums will be used for the prioritisation of areas and projects. Where no such structures exist, the provincial RDP co-ordinator will be approached to facilitate the formation of a new structure.

2. Forums will no longer be able to determine electrification plans without consideration of financial implications. Changes to Eskom's least-cost plans will only be made if these have no financial implications, or if additional funds from an external source will be made available to cover additional costs.

The first of these is already being implemented by Eskom. However, the organisation is experiencing difficulties in some areas where suitable structures do not exist, and the provincial RDP co-ordinators have not taken on the responsibility of establishing such structures, for example in the former Lebowa (Sterley 1995).

In conclusion, a few observations will be made concerning the future development of consultation policies. In the first place, the need for a national policy framework concerning the consultation processes used in the planning of electrification, which has political legitimacy and is underwritten by the government, has been raised by Eskom (Pretorius 1995). In the present situation, the onus is on Eskom to develop policy on this matter, as well as to ensure its implementation, and this exposes them to severe criticism.

Secondly, the local government structures which will be established in rural areas in the near future are expected to play an important role in the prioritisation of electrification projects within their areas of jurisdiction. However, the respective roles of different developmental structures – such as those formed by the RDP at a sub-regional level, and local government structures in these areas – will need to be clarified.

Finally, it is significant that no provision had been made in the past for consultation with representatives of farmworkers in the planning of electrification. This reflects their lack of status and power, being dependent on farmers for their livelihood and for the provision of services, including electrification (see below) – which is probably also one of the main reasons why farmworker electrification is not given priority at the present (see chapter 6). Although farmworkers should be represented in future local government structures, it may be necessary in the future to take special measures to include them in forums where decisions are made on electrification.

4.4.3 Consultation at community level

Eskom has generally facilitated the establishment of electrification committees or leadership forums in settlements to be electrified, mainly to enable communication with the communities concerned (Eskom 1994a). In practice some of these committees have effectively been appointed by local traditional leaders (Potgieter 1995). The committees are generally responsible for liaison between Eskom and contractors on the one hand, and the local community on the other. They are involved in practical decisions concerning the implementation of projects, such as the use of local labour for construction, the use of underground versus overhead connections, and the selection of vending outlets for electricity tokens (Kinneer 1995; Potgieter 1995). Mass meetings are also held during which Eskom communicates directly with people from the area.

However, no provision is currently made for the involvement of particular communities in the *planning* of projects – liaison with a community only commences once a project has been approved (Eskom 1994a; Potgieter 1995). This approach will probably need to be revisited in the future, particularly if load-limited supplies are to be implemented on a large scale⁶.

⁶ Eskom has conducted drawn-out negotiations with some communities where 2.5A load-limited supply is to be provided to test these systems.

5. Other household grid electrification programmes

In this chapter a few of the smaller household grid electrification programmes which have included electrification in rural areas, will be discussed briefly to provide a broader picture of the experience in South Africa to date. The electrification programme currently undertaken by Durban Electricity, which forms part of the national programme, as well as the ongoing programmes run by the utilities of the former Venda and Bophuthatswana homelands, will be considered here. Information on the electrification programmes of most of the former homeland distributors is difficult to come by, for reasons such as the poor management of these institutions and inadequate reporting procedures, as well as the recent demise of most of them. The two major exceptions seem to have been the utilities in the former Venda and Bophuthatswana homelands (Horvei & Dahl 1994).

5.1 Durban Electricity

Durban Electricity (DE) embarked on its *Electricity for all* (EFA) programme in late 1991, undertaking to connect an additional 168 000 homes over five years at an estimated cost of some R500 million (Durban Electricity 1991). At that time DE served 288 452 customers and it was estimated that, if 168 000 new household connections could be made, close to 100% of households in its area of supply would have access to electricity (Durban Electricity 1991). As discussed before, parts of the former KwaZulu homeland which are regarded as 'rural' areas, are included in DE's area of supply. However, all settlements in this area may be described as being 'functionally urban', in that households tend to rely on workers in the city who commute on a regular basis.

5.1.1 The approach to electrification

Individual households are invited to apply for electricity, and those which are connected as part of the EFA programme, are required to pay a R142.50 fee on application (Durban Electricity 1995a). This fee covers the donation of a free two-plate hotplate (i.e., an enforced purchase).

In principle, once applications have been received, the electrification planning departments are required to respond to these requests and plan the extension of the network to reach applicants. However, this is not always possible in practice, and it is common for extensive consultation to occur between DE and local communities or their representatives before construction can begin. There appears to be some conflict between responding to applications and rationally planning the gradual extension of the distribution network (Alvar 1995). The current practice appears to aim at establishing a distribution network throughout DE's area of supply and connecting those households who have made applications. Attempts are made to promote connections to the distribution system once it is installed in an area. The establishment of the distribution network is already close to completion.

Household connections generally provide a prepayment meter and a ready-board inside the house. The tariff generally used for EFA connections (Schedule 8) is exactly the same as the Eskom Homelight 1 tariff (i.e., an energy charge of 25.81c/kWh and no fixed monthly charge). This tariff is available to all new customers in an EFA area, including small shops and community facilities (Durban Electricity 1995a). Electricity tokens are made available through local shops. However, the provision of adequate vending points has been hampered by a lack of equipment (Alvar 1995).

Schools, clinics and religious buildings in the areas which are electrified, are always connected as part of the EFA programme. Funding from the Eskom schools and clinics fund has been used to provide internal wiring in schools (see below). Many clinics are mobile and so do not require electricity supply points.

Streetlights are always provided and operating costs are paid by Durban municipality. In most cases extensive lighting is provided, particularly along roads. However, costs are

reduced by restricting streetlights in areas where it is not considered to be as important. Street lighting is seen by residents as one of the major benefits of having electricity, particularly given the violence and instability in many of these settlements. Each streetlight has a light-sensitive switch and installed costs are in the region of R350 per light (Alvar 1995).

5.1.2 Experience to date

By June 1995, DE had connected 74 003 households and reported that it was lagging behind its target of 132 000 (Durban Electricity 1995b). Delays have been the result of both technical factors, such as availability of equipment and delays on network construction; and non-technical factors, including access to politically unstable and violent areas, allocation of upgraded sites and security of tenure (Durban Electricity 1995b).

A total of R359 million has been spent on capital projects so far, at a cost per connection of R4 863. This is 56% higher than originally planned (Durban Electricity 1995b). However, costs per connection have been declining in nominal terms since inception (in 1991/2 costs per connection were R6 094). This represents a large real decrease in costs and is largely due to the increase in new connections on installed infrastructure.

In general, take-up rates are lower than what Eskom has experienced, which can probably be attributed to the higher connection fees and the policy of only connecting applicants. Estimates of take-up rates vary between 100% and 30% in different areas. Take-up rates are relatively high in many areas in the former KwaZulu, apparently because these households are fairly well-established and often household members are employed in Durban. It is hoped that the rate of connection will increase gradually over time once the basic infrastructure has been installed. DE has experimented with the policy of connecting all households in an area, irrespective of whether an application is made or not. However, this practice was not adopted as policy as it was not found to improve the financial viability of the programme (Whitehead 1995).

The average consumption rate has been declining over the past four years: in 1991 it was 180 kWh/month, and it is now 123 kWh/month (Durban Electricity 1995b).

One of the main problems experienced by the DE has been the conflict and violence in Natal, political or criminal, which has hampered negotiations with communities and endangered the lives of people involved in the programme, thus seriously hampering the electrification programme. Problems were also at first experienced with faulty prepayment meters, but most of the teething problems appear to have been sorted out. Theft of electricity through bypassing prepayment meters is an area of concern, particularly in urban areas. Possible solutions which are being investigated include the use of a 'split meter' with pole-mounted electronic equipment and more tamper-proof box designs. Sales lists are also scanned for customers who do not consume electricity, and these are visited – although the task of disconnecting these customers is complicated by the levels of violence and intimidation in some areas (Durban Electricity 1995b). Apart from loss of revenue, Durban electricity finds that strategies to address electricity theft are in themselves expensive.

5.2 Venda Electricity Corporation (VEC)

The VEC, now the Venda National Development Corporation: Electricity Division, was formed in 1987 as the public utility of the former Venda homeland. At the time about 3 000 households in urban towns had already been electrified by the Venda government. VEC has since increased the number of household connections to approximately 20 000. It has been estimated that this constitutes about 15-20% of the households in the Venda area (Bele 1995).

The number of connections made per year has increased from approximately 800 at first to about 4 000 in 1994. However, the connection rate has slowed down in 1995 because of financial difficulties. Thus, although the target for 1995 was 5 000, only about 200 households have been connected per month during the first half of the year (Bele 1995). The financial problems have resulted in particular from the termination of the subsidy which had been received from the former Venda government when the new South African government came into power in April 1994 (see below).

Most of the connections made by VEC have been in areas outside of municipal boundaries, although not necessarily outside of 'functionally urban' areas. (Horvei and Dahl (1994) have pointed out that some of Venda's 'rural' areas are characterised by relatively large and dense settlements.) In 1993 'rural' households comprised about 70% of their domestic customer base (Horvei & Dahl 1994), and this is unlikely to have changed significantly since then.

A connection fee of R380 is charged in 'rural' areas (compared to R350 in proclaimed urban areas), and only households who have paid the fee are connected (Bele 1995). It is likely that, because of this policy, VEC's residential customers have tended to be more affluent households who can afford the connection fee. This seems to be reflected in the reported consumption rates: the average consumption for newly connected households is said to be about 100 kWh/month, which increases with time up to about 250 kWh/month (Bele 1995).

All residential customers are provided with a 60A supply and a conventional meter. Apparently the possibility of introducing prepayment meters was considered, but rejected on technical grounds (Bele 1995). The capital cost per connection has been in the range of R4 000 to R6 000, but has reportedly been dropping recently because of larger numbers of 'fill-in' connections.

The tariff applying to domestic customers comprises an energy charge of 11.15 c/kWh and a fixed monthly charge of R13.29 (excluding VAT), which has not changed since 1993 (Horvei & Dahl 1994). At the time it reflected the Venda government's policy of subsidising the unit cost of electricity by 50%. The tariff has not been increased since then because of the politically sensitive nature of such an increase and the political uncertainty during this time (Bele 1995).

Some of the problems which have reportedly been experienced in the rural areas include difficulties in negotiating access to tribal land for providing servitudes, low settlement densities (average plot sizes of 40m x 50m) with resultant high costs, and the inability of people in rural areas to pay the connection fee (Bele 1995).

5.3 Bophuthatswana Electricity Corporation (BECOR)⁷

BECOR is a much larger utility than VEC. In January 1994 BECOR had about 69 200 domestic customers, which had increased to about 96 700 by June 1995 (Matthews 1995). Four domestic tariffs are in use, the details of which are summarised in Table 7.

Tariff	Domestic and small (1)	Circuit breaker (2)	Dispenser (3)	Low connection (4)
Basic service charge per month	R11.66	R11.66	-	-
Energy charge per kWh	16.04c	-	16.71c	22.64c
Flat-rate charged per month	-	R16.04 (5A) R30.63 (10A) R46.68 (15A)	-	-
Number of customers (June 1995)	29 966	2 399	42 215	22 093

Note: All tariffs are exclusive of VAT.

TABLE 7: BECOR domestic electricity tariffs (1995)

Source: Matthews (1995)

Tariff 1 is generally applied to small consumers (with maximum demand no more than 25 kVA), while tariff 2 is used when consumers are provided with a load limited supply. The connection fees which correspond to these tariff categories are variable in rural areas, depending on the actual costs of connection (Matthews 1995). The number of consumers in both these categories have declined between January 1994 and June 1995, for reasons such as

⁷ Only limited information was obtained on BECOR's programme, as the utility could not be visited during the review.

the disconnection of consumers, as well as the transfer of consumers to the tariff 5 category (*ibid*).

BECOR started using electricity dispensers and prepayment meters for domestic consumers a few years ago (Horvei & Dahl 1994). Tariff 5 and 6 are both used in conjunction with prepayment meters. A low connection fee (about R45 - i.e., similar to Eskom's Homelight connection fee) is charged to connect new consumers in the tariff 6 category (Matthews 1995). No connection fee is charged with respect to the tariff 5 category, however, as this mainly comprises consumers who had previously been in another tariff category (for example, on tariff 1) and had thus paid a cost-reflective connection fee.

5.4 Discussion

A few observations can be made about the smaller household grid electrification programmes, as compared to Eskom's programme. In general, these programmes appear to have focused mainly on areas which could be regarded as 'functionally urban', as opposed to 'deep rural' areas. Different connection policies, tariffs and metering options have been employed by the various utilities, which often differ from those currently employed by Eskom. This generally makes comparison between programmes very difficult, for example, comparison with respect to costs, take-up rates and consumption rates.

Furthermore, most of these smaller programmes, particularly those conducted by the former homeland utilities, have been poorly documented, in addition to being poorly planned and managed in many cases. As a result, little benefit has been derived from their experience to date. Nevertheless, some aspects of the smaller electrification programmes may be of value to the development of future policies. For example, BECOR's experience with respect to the implementation of load limited supply and circuit breaker tariffs may be of value in light of the proposed changes in Eskom's policy.

6. Farmworker electrification

As discussed before, while Eskom is the main distribution agency involved with the electrification of farmworkers, this group is not included in its current electrification programme, but is dealt with in a way entirely different from that used for other rural groups. In this chapter Eskom's policy with respect to farmworker electrification, the experience to date, and recent developments concerning this matter will be discussed.

6.1 Eskom's current approach to farmworker electrification

Farmworker electrification is not a priority of Eskom at present, as the organisation mainly sees itself in a supporting role in this regard. Farmers themselves and provincial/district authorities (such as the Regional Services Councils (RSC's) in recent years) have been expected to drive the electrification of farmworker houses. Eskom's current policy on farmworker electrification is set out in the document 'Electrification of workers houses - Policy and guidelines' (Barnard 1991). Four options are provided for the electrification of farmworker houses, and are summarised in Table 8.

Strategy	Workers not direct Eskom consumers		Workers direct Eskom consumers	
Method	Independent farmer extensions (1)	Farmer extension with Eskom assistance (2)	Limited Eskom tariff S1 supplies (3)	Standard Eskom tariff S1 supplies (4)
Eskom financial assistance	none	R300 for network extension and R100 for appliances per house	R700 for network extension and R100 for appliances per house	R2000 per house
Tariff	Landrate (D)	Landrate (D)	Homelight (S1)	Homelight (S1)
Responsibility for payment	farmer	farmer	workers	workers
Responsibility for maintenance	farmer	farmer	shared by farmer and Eskom	Eskom

TABLE 8: Options for the electrification of farmworker houses by Eskom
Source: Barnard (1991)

Eskom's various tariff options pertaining to rural areas are discussed in some detail in Appendix A. The tariff which is applicable when methods 1 and 2 are used - the Landrate or 'D' tariff - is generally applied to farmers. It comprises a basic monthly charge for each point of supply, graded according to the customer's installed capacity, and an energy charge. The basic charge is currently between R72,98 per month (for installed capacity up to 25 kVA) to R149,21 per month (for installed capacity between 50 and 100 kVA)⁸. The energy charge is currently set at 28.67c/kWh for the first 1000 kWh consumed in a month, and 16.58c/kWh for consumption beyond that. (All these prices include VAT.) The tariff covers the costs associated with the supply point, including the transformer, metering equipment and 200m of line. A monthly rental is payable to cover capital expenditure over and above these. The Homelight tariff which is applied when methods 3 and 4 are used, has already been discussed in chapter 4.

The conditions under which the different methods are applied by Eskom, in addition to the normal conditions applicable to the electrification of farms, are as follows:

Method 1: No additional conditions.

Method 2: A minimum supply of 30 A per house must be provided; sub-metering per house is preferred; and Eskom should be allowed to market electricity and provide education to users.

⁸ A different tariff is applicable when installed capacity exceeds 100 kVA.

Method 3: Between 10 and 50 houses are required; worker houses must be metered independently; the farmer must sign a support agreement; and the viability of the project should be assessed by Eskom.

Method 4: More than 50 houses are required; and the viability should be assessed by Eskom.

It is of interest that, where method 3 is used, the farmer has to undertake to transfer his existing energy expenditure on behalf of the workers to them in some form, clearly with the intention to increase their disposable income. The support agreement signed by the farmer in such cases makes him responsible for first-line maintenance and administration, with the aim to reduce the service costs incurred by Eskom. The policy also states that farmworkers who are directly electrified by Eskom using methods 3 and 4, are not expected to share the existing line costs borne by farmers. Method 2 is generally preferred by Eskom, and is also applied in most cases.

A review of current practices within Eskom regarding the electrification of farmworker houses, was recently conducted by a national task team in Eskom. Its findings can be summarised as follows (Eskom 1995d; Van der Walt 1995):

- Eskom's policy as outlined above is generally applied, and in most cases electrification is done using method 2.
- Eskom's farmworker electrification policy is mainly implemented through its sales department, i.e. the Agrelek advisors who deal with farmers, although in some SACS areas the electrification or customer services department is also involved.
- A limited number of RSC's are involved nationally in the financing of farmworker electrification, with contributions generally ranging from R500 to R2500 per house. In some cases a maximum is set per farm (for example, four houses per farm at R1000 each).
- In general the farmer is held responsible for the difference between the actual cost of electrification, and the combined contributions of Eskom and the RSC (where this is available).
- The rate at which farmworkers are connected, are generally low, particularly in areas where no contribution is made by the RSC, or where the contribution is less than R500 per house.
- Conventional metering systems are used in most cases, although significant numbers of prepayment meters are also being used.
- In the majority of cases the farm owner is held responsible for payment of the electricity used by the farmworkers, although the owner has the option to obtain payment from the workers.
- The estimated national average consumption per household is in the range of 40-70 kWh/month, although high consumption rates of up to 550 kWh/month have also been reported.
- In most SACS areas farm schools are not connected as part of the farmworker electrification projects.
- There is a serious lack of accurate information on the numbers of farmworker houses on farms, which hampers planning at a national and provincial level.

The latter has been pointed out before, and seems to be one of the most serious problems which will need to be addressed if farmworker electrification is to take place on a larger scale.

A number of questions can be raised about the way in which Eskom is currently dealing with farmworker electrification, which basically stems from the fact that the utility sees itself in a supporting role in this regard. One of these is the absence of a properly planned and co-ordinated national farmworker electrification programme, with specific objectives and allocated responsibilities. At present the responsibility for this activity within Eskom lies mainly with Agrelek advisors whose primary objective is to increase the sale of electricity on farms. They have very little incentive, therefore, to focus on farmworker electrification which

involves low levels of consumption. As a result, farmworker electrification is not given a high priority by them, and is generally done in an ad hoc manner.

In cases where regional farmworker electrification programmes have been implemented on a relatively large scale, for example in the Free State (see below) and the Western Cape (Hofmeyr 1994), the initiative taken by the regional Eskom offices seems to have been one of the important factors contributing to the success achieved. However, an approach which leaves this matter to the initiative of individuals within the organisation, is unlikely to achieve significant improvements in farmworkers' level of access to electricity, as is evident from the current connection rates pertaining to farmworkers (see Table 3).

In addition, some aspects of the policy on farmworker electrification may also require some scrutiny. Hofmeyr (1994) has pointed out that farmers often control the extent to which workers can utilise the electricity supply – by, for example, limiting the types of appliances which can be used, or restricting the number of hours per day that workers have access to electricity. This is understandable practice under conditions where farmers are held responsible for payment of the electricity consumed by users, as is generally the case. Possible changes to this policy may need to be considered to provide greater autonomy to farmworker households in making decisions concerning energy use (Hofmeyr 1995).

6.2 Current developments in Eskom's approach

Some recommendations have been made by Eskom's national task team on farmworker electrification, based on the national review which was discussed above (Eskom 1995d). An Eskom strategy document on farmworker electrification is currently being compiled, which will draw on the work of the national team. The following is an attempt to summarise the recommendations which are likely to be made, based on the recommendations of the national team to date and discussions with the co-ordinator (Van der Walt 1995):

- Eskom should formulate a national policy on farmworker electrification in consultation with the RDP office. The priority which should be given to this activity by Eskom needs to be established, as well as the implications in terms of Eskom's financial contribution per connection and specific connection targets. The current Eskom policy on farmworker electrification (as discussed above) should, however, form the basis of Eskom's future involvement in this area.
- An Eskom manager should be appointed with overall responsibility for this activity at a national level. The electrification of farmworker houses should be seen as projects, similar to electrification projects generally, which are handed to the relevant SACS area when completed (that is, they must be integrated with normal Eskom business).
- It is not appropriate to introduce a standardised approach to such projects in all SACS areas. In particular, the specific Eskom department which should be responsible for this activity in each local area (i.e., within SACS areas) should be decided within the Co-ordinating Liaison Committee in each SACS area, in consultation with local/district institutions responsible for development. However, the Eskom personnel who will be responsible for this activity should be set goals which are in accordance with aims of the initiative and its regional/national priority, and are not strictly sales-related, as in the case of Agrelek advisors.
- The involvement of government institutions such as the RSC's in providing financial and other forms of support will be vital to ensure the success of this activity.
- In order to plan such an initiative and to set annual targets, it will be critical to determine as accurately as possible the number of farmworker houses which need to be electrified.

If these measures were implemented it would significantly improve the current situation with respect to farmworkers' access to electrification. However, as discussed above, it may also be necessary to assess some aspects of the current Eskom policy on farmworker electrification if this is to be retained.

6.3 Farmworker electrification in the Free State

The farmworker electrification programme in the Free State⁹ will be discussed here in some detail, as it has not been adequately documented as yet, and has provided some valuable experience with respect to the electrification of farmworker households in a fairly typical farming area in South Africa by means of a structured programme.

The programme commenced in August 1989. It was initiated by Eskom's Bloemfontein distributor and the Bloemfontein district 'Boere-unie' (Farmers' Union), which approached the Bloemarea RSC about financing for the electrification of farmworker houses. At present three of the four RSC's in the Free State are involved in the programme: Bloemarea RSC which operates in the western and southern areas, 'Goudveld' RSC in the north-western area, and Eastern Free State RSC. The Northern Free State RSC is not involved, and this area is therefore excluded from the programme, although Eskom's farmworker electrification policy is implemented there through Agrelek advisors.

In the rest of the Free State farmworker electrification is done mainly through the joint RSC/Eskom programme, although some electrification also occurs through Agrelek advisors. Eskom is acting as an agent for the RSC's in this regard. In order to implement the programme, two employees in the electrification department of the Eskom's Bloemfontein office have been dedicated to this programme.

6.3.1 *The approach to electrification and progress to date*

In this programme farmworker electrification is done almost exclusively according to method 2 set out in Eskom's policy (see above), which had been pioneered in the Free State. This allows for a once-off contribution by Eskom to the value of R400 per house which is electrified, and Eskom is further allowed to market electricity and provide education to the users. Consumption by the farmworkers is included in the farmer's electricity bill, using the Landrate tariff, and the responsibility for the payment of electricity lies with the farmer. The farmer owns the electricity supply to the farmworker houses, and is responsible for maintenance.

Most farmers in the Free State apparently subsidise the electricity use of the farmworkers, although there are some who hold the workers responsible for their entire bill. Eskom encourages farmers to pay workers in cash the amount by which they would be willing to subsidise their electricity use, rather than paying the electricity bill on behalf of the workers (Wilken & Ploos van Amstel 1995).

Farm schools which are located close to farmworker houses are included in the programme, and treated as additional houses. However, if a school is too far to be included in a project at a reasonable cost, funding for the electrification of the school is requested from Eskom's Community Development Fund. Generally there are no clinics on farms, which are served by mobile clinics.

Since its inception until the end of May 1995, a total number of 14 612 farmworker houses have been electrified as part of the programme, using grid electricity (Wilken & Ploos van Amstel 1995). (This includes 1 760 households that were electrified during the first five months of 1995.) This constitutes about 27% of all the farmworker connections which have been made by Eskom nationally (see Table 3). In addition, 108 schools and clinics have also been electrified as part of the programme to date.

6.3.2 *The financing of the programme*

In 1989 Eskom estimated that, on average, the costs per farmworker connection in the Bloemfontein district would be R1 800. The current subsidy provided by the Bloemarea RSC (R1 600) has been based on an average cost of R2 000 per connection, taking into consideration the contribution of R400 made by Eskom. The other RSC's have different funding policies, which reflect the differences in farming practices and typical farm sizes, which affect the costs per connection, in different parts of the Free State. For example, in the southern parts large

⁹ The information reported here has been provided by Wilken and Ploos van Amstel (1995).

sheep farms of 1 600 ha are the rule, while relatively small fruit farms are common in the eastern parts. The funding policies in different RCS's are summarised in Table 9.

	<i>Bloemarea RSC</i>	<i>Goudveld RSC</i>	<i>Eastern Free State RSC</i>
<i>RSC contribution per house</i>	R1 600	R1 500	R1 200
<i>RSC restrictions</i>	none	maximum of 10 houses annually per farmer	maximum of 10 houses annually per farmer
<i>Eskom contribution per house</i>	R400 (no appliance)	R300 and two-plate stove	R300 and two-plate stove

TABLE 9: Funding policies of RSC's in the Free State

Source: Wilken and Ploos van Amstel (1995)

In the Bloemarea, the RSC negotiated with Eskom to provide a subsidy of R400 rather than R300 and a two-plate stove, because of the relatively high costs of electrifying houses in that area. No limitation has been set in this area on the number of houses which can be electrified annually per farmer, as it is more cost-effective to electrify larger numbers of houses where these are present. However, in all the areas there is the provision that farmworker houses on a farmer's 'woonplaas' (i.e. the farm used by the farmer for residential purposes) must be electrified first, and that houses on additional farms cannot be electrified in the same year as those on the main farm. A separate application has to be made by the farmer to electrify houses on additional farms.

6.3.3 The planning process

Application forms are distributed to farmers by the representatives of the 'Landelike Rade' (Rural Councils) from each magisterial district. These representatives also collect the completed application forms. A priority list is generally compiled for each magisterial district on a 'first-come first-serve' basis. In the application forms, farmers have to provide some basic information on the layout of their farms, particularly the location of existing electricity supply points and farmworker houses. This information is checked by Eskom personnel (in the areas surrounding Bloemfontein) or the contractors appointed to do the installation (in other areas). An open tender process is used to appoint electrification contractors in the Bloemarea, while contractors are generally nominated by farmers in all the other districts.

Eskom is informed each year of the budgets which the RSC's have allocated to farmworker electrification, and uses this to plan the electrification of the maximum number of worker houses possible (Wilken 1995). However, as the demand for electrification is high compared to the financing available, there is generally a significant delay between the application for electrification and the implementation of a project.

Farmers may also apply for a refund by the RSC's for electrification of worker houses which had been conducted and financed by the farmer, as long as this had been done after the establishment of the RSC, and to an acceptable standard. Some farmers still choose to electrify their worker houses themselves, e.g. if they are not willing to wait until they can be assisted through the programme. In these cases Eskom arranges an inspection of the installation before the refund is approved.

6.3.4 The technology options employed

A number of technical options are available for the electrification of farmworker houses, and Eskom advises the farmers on the most cost-effective option. The following rule of thumb provides an indication of the main reticulation options (Wilken & Ploos van Amstel 1995):

- for eight houses up to a maximum distance of 400m from an existing supply point, a low-voltage underground cable is provided
- for eight houses at a distance between 400 and 800m from an existing supply point, a low-voltage bare overhead cable is provided

- for eight or more houses at a distance greater than 800m, an intermediate voltage system is installed

A typical configuration is about seven houses at a distance of 300m from the supply point. The cost of the cable generally accounts for more than 50% of the total project costs. The least-cost option is generally chosen, also when the cost per connection is less than the amount provided for by the subsidy and Eskom's contribution. In such cases only the actual costs are covered by the subsidy. In cases where the cost exceeds the financing available, options to reduce the cost are investigated. Generally farmers are responsible for the digging of trenches and holes to install the line, while materials are purchased in bulk through the RSC's to reduce costs. Although contractors are generally based in cities such as Bloemfontein and Welkom and large towns, a standard contractor fee is used in all cases (Wilken & Ploos van Amstel 1995). In some cases a farmer may choose a more expensive option based on considerations such as the need for an additional point of supply, in which case he would be expected to bear the difference in cost.

Farmworker houses are generally provided with a 30A supply. Houses are generally wired, but a ready-board is provided as an option to reduce costs where necessary. Eskom generally provides a light per room and two plugs per house, but some farmers restrict the number of plugs to one per house (Wilken & Ploos van Amstel 1995). This often depends on the total cost of the installation and the contribution that would be expected of the farmer. No housing standards have been set for wiring, and adobe (wattle and earth) houses are frequently wired in the Eastern Free State. In most cases meters are installed in each house. Conventional meters are generally used because of the relatively high cost of prepayment meters. However, some farmers have expressed a preference for prepayment meters which they see as a way to prevent the uncontrolled use of electricity by workers.

The actual cost per connection is just more than R2 000 on average in cases where an existing point of supply can be used (Wilken & Ploos van Amstel 1995). The highest cost per connection in a project electrified as part of this programme, was R3 500.

6.3.5 The use of RAPS systems

The farmworker electrification programme in the Free State makes provision for the electrification of farmworker houses using photo-voltaic systems. These are mainly installed when the houses are located on isolated 'veeposte' (e.g. cattle posts) where there are no existing points of supply. In some cases it is also recommended to farmers if all other options for electrifying the houses prove too costly. The same procedure is followed as described above. However, Eskom makes no contribution to the capital cost of installing these systems. The subsidies provided by the Goudveld and Eastern Free State RSC's are the same as for grid electrification, while the Bloemarea RSC provides a higher subsidy (R2 000 per house). A 12-volt system is generally provided with one light per room (as far as possible), and one plug (suitable for a radio or black and white TV) per house. Since 1991 a total of 713 houses have been electrified as part of the programme in the Free State using PV systems, including 172 in the first five months of 1995 (Wilken & Ploos van Amstel 1995).

7. Schools and clinics electrification

Community facilities in rural areas such as clinics, water supply systems, public lighting, and schools, all provide important services in these areas. Current initiatives to electrify such facilities focus mainly on clinics and schools, which have been given priority by the government (ANC 1994).

Two major initiatives exist which focus on the electrification of schools and clinics, and provide financing for such projects: the Independent Development Trust's (IDT) clinic electrification programme which forms part of the broader rural energy programme under the Health & Rural Development Portfolio, and Eskom's schools and clinics electrification programme which is co-ordinated by the National Electrification Planning department. In addition, the Non-grid Electrification Group in Eskom's Technology Research & Investigations (TRI) has recently embarked on a RAPS electrification programme aimed at schools and clinics.

The planning of clinics and schools electrification is hampered by the lack of accurate information on the numbers of unelectrified clinics and schools, their location, including their location in relation to the grid, and the nature of their energy needs. For example, as discussed in chapter 2, estimates of the number and percentage of unelectrified schools and clinics vary considerably. This also makes it difficult to assess the progress which is being made.

About 252 clinic electrification projects funded by the IDT are underway or have already been completed, comprising about 28% of the estimated 900 existing unelectrified clinics. It is not clear how many clinics the IDT is planning to electrify in its programme, however, although the overall target is to achieve 85% electrification of all clinics.

Based on their estimates of the numbers and percentage of unelectrified schools and clinics, and taking into account new clinic and school building programmes¹⁰ as well as Eskom's grid electrification programme (but not the IDT and TRI programmes), Eskom has estimated that approximately 75% (15 178) schools and 47% (2950) clinics would still be unelectrified by the end of 1999 (Theron 1995a). It has also been estimated that approximately R850 million would be required to electrify all schools and clinics by the year 1999 (Hambly et al 1994).

7.1 The IDT's clinic electrification programme

The IDT's mandate is to address the needs of the 'poorest of the poor'. Arising from this, the IDT's rural energy programme has focused much of its efforts on electricity supply for rural community facilities (mainly clinics, but also some schools) as the primary mechanism for providing access and benefits to the poor in an equitable manner. General clinic/health care facility classifications are as follows:

- *Mobile clinics*, consisting of teams of sisters who travel to rural stopping points on a regular basis. Stopping points may consist of visiting points or any other structures provided by the community.
- *Visiting points*, which usually are buildings used as stopping points for mobile teams. These may comprise two or three rooms, and possibly an associated community hall. Information on the location and nature of visiting points in South Africa is very incomplete.
- *Day clinics*, which have no accommodation for nurses or maternity wards, and are only open during the day. Otherwise they offer services comparable to residential clinics.
- *Residential clinics*, which include nurses' accommodation and maternity wards, usually offer 24-hour service in case of need, and may typically have a staff of four sisters and two assistants.

¹⁰ It was assumed that the IDT will build approximately 200 new clinics per annum and the Department of Education and Training approximately 133 schools per year for the next five years.

- *Health care centres*, which offer 24-hour service and have staff accommodation. They are larger than residential clinics.

Estimates of the total numbers of urban and rural¹¹ clinics, as well as unelectrified clinics in South Africa are presented in Table 10.

Province	Total number of clinics (electrified and un-electrified) ¹			Number of major clinics un-electrified	Number of visiting points un-electrified
	TOTAL	Urban	Rural		
Gauteng	430	428	2	0	0
North-West	290	127	163	125	8
Northern Province	400	48	352	282	10
Eastern Transvaal	220	95	125	100	7
Free State	240	177	63	5	30
Northern Cape	120	94	26	5	20
Western Cape	450	428	22	0	25
Eastern Cape	450	249	201	317	40
KwaZulu-Natal	348	271	77	77	31
TOTAL	2948	1917	1031	901	161

1 Residential clinics, day clinics and health centres

TABLE 10: Numbers of clinics (electrified and unelectrified) per province
Source: IDT (1995c)

In addition, new clinics are being built as part of the IDT's clinic building programme, which is summarised in Table 11.

	Clinics completed and in pipeline	Clinics planned but not yet approved
Urban	30	21
Rural	312	73

Note: These range from residential clinics to visiting points.

TABLE 11: IDT clinic building programme
Source: IDT (1995c)

It has been estimated that a further 150 clinics will need to be built over the next five years in addition to those constructed as part of the IDT programme (IDT 1995c). This will probably be done under the co-ordination of the national Department of Health's Clinic Upgrading and Building Programme.

7.1.1 Projects included in the programme

The IDT is involved in rural clinic electrification in the following ways (IDT 1995c):

- The funding of a proportion of the extension of the electrical network by utilities. This has been defined as the 'un-economic portion' of the extension of feeder lines to rural settlements where there is a clinic.
- The funding of the upgrading of the wiring and the electrical installation at clinics which are to be grid-connected.

¹¹ The IDT defines 'rural' as those areas falling outside the functionally urban areas as defined by the DBSA (DBSA 1991).

- The funding of the extension of the network to existing un-electrified hospitals in the Eastern Cape Province.
- The funding of the upgrading of the electrical installation of selected rural hospitals.
- The funding and implementation of the electrification of off-grid clinics.
- The provision of the full electrical supply for off-grid clinics, including the power supply, wiring, lighting and some equipment.
- The funding of the electrical system for nurses quarters associated with off-grid clinics.
- The funding of a proportion of the maintenance costs of off-grid clinics during their design life.

IDT electrification activities have largely concentrated on residential clinics to date, and programmes to address the energy needs of smaller clinics and visiting points have only recently been launched. This document therefore dwells mainly on residential clinic electrification. In addition, particular attention will be given to off-grid electrification of clinics, as the IDT has been more directly involved with off-grid supply than grid electrification, which has generally been conducted by the utilities using IDT funding.

7.1.2 The programme budget

Cost estimates of the capital expenditure on the electrification of major clinics as part of the IDT programme are presented in Table 12.

Province	No of major un-electrified clinics ¹	Cost of grid elec (R million)	Cost of off-grid elec (R million)	Total elec cost (R million)
North-West	125	2.0	5.08	7.08
Northern Province	282	2.0	11.0	13.00
Eastern Transvaal	100	0.5	3.7	4.30
Free State	5	0.5	0	0.50
Northern Cape	5	0.5	0.5	1.00
Eastern Cape	317	8.0	12.30	20.30
KwaZulu-Natal	77	1.7	3.45	5.15
TOTAL	901	15.2	36.03	51.08

1 Total number of unelectrified clinics, all of which will not necessarily be electrified as part of the IDT programme

2 Include past and current IDT projects

TABLE 12: Total clinic programme cost estimates²

Source: IDT (1995c)

In addition to the funding for the electrification of existing clinics which is shown in the table, funding to electrify a further 250 new rural clinics is being sought by IDT. Also, R 5 million has been allocated to minor clinic electrification, bringing the total funds allocated by the IDT to capital expenditure on clinic electrification to R 54 million. A further R 4.5 million has been set aside for the longer-term maintenance of off-grid clinic electricity systems (see below).

7.1.3 The planning of the programme

Initially planning was done using the former homeland borders as planning units. This has changed with the new regional demarcations, and planning and implementation is now undertaken along provincial lines. For example, the former Ciskei and Transkei are now included in the Eastern Cape region. For practical reasons the Eastern and Northern Transvaal provinces have been placed together in one planning unit.

The total IDT electrification budget has broadly been divided amongst provinces according to (i) total population, (ii) number of health points, and (iii) mortality rate in each area. In practice this has not been so simple, however, with planning delays in some areas leading to budget

diversions in favour of other areas where extra resources were necessary. The information from the DBSA which was used to do the initial budget allocations, has also been found to be of questionable reliability. Furthermore, resources required by each area have varied with changing rural electrification plans and developments in rural health planning (e.g. clinic location). For example, it has recently become apparent that substantial funds may need to be diverted to addressing electricity needs of rural hospitals (not just clinics) if rural health care is to be significantly improved.

Furthermore, the national and provincial Departments of Health are currently conducting a major planning exercise with a view to developing a more rational spatial network of health services. As a result sub-standard or poorly located clinics may be closed or demolished, while others may be built to ensure equitable regional coverage. It is also reviewing the roles of different types of health care facilities in rural areas, such as the role of visiting points. In the light of these factors, the IDT is considering the revision of current budget allocations on a provincial basis as well as amongst hospitals, residential clinics and visiting points.

Unelectrified clinics are identified in consultation with the provincial Departments of Health and/or Works. The RheMIS Health Facilities Database is used here in conjunction with the IDT's National Clinic Database¹². Whether clinics are to be grid connected or to receive off-grid supply is decided in consultation with Eskom (at regional level) or the local utility. Factors considered here are the location of the existing grid and planned electrification activities of the utility. This process is often problematic, however, as firstly, the location of the existing grid may not be accurately known¹³, and secondly, rural electrification plans are usually far from complete, having recently been developing at a fast rate. The clinic identification process is therefore not a smooth one, and mistakes are made. (In one case, after a lengthy process of clinic identification involving a local utility, the consultant and contractor arrived at a site identified for a PV system, and found a newly installed 22 kV grid point just 60 meters away.)

7.1.4 The selection of technology options

The IDT is currently using the following broad guidelines for residential clinic energy source technology:

- Clinics close to the national grid (usually within 5 km) - grid electrification.
- Clinics between 5 and 10 km from the grid - genset-plus-battery system for electrification of clinic and nurses home, with LPG vaccine refrigeration.
- 'Deep rural' clinics (over 10 km from the grid) - full PV electrification of clinic and nurses home (including vaccine refrigeration).

The first of these is currently under review in the light of Eskom's expanding grid electrification programme in rural areas (IDT 1995c). The second guideline reflects the possibility of grid electrification in the medium term in areas not considered as 'deep rural', where the IDT has therefore opted for a system with lower capital cost than a full PV system. They have requested the assistance of the oil companies in improving the reliability of the gas distribution network, and have developed a system of gas use which ensures that the supply to the refrigerator receives priority. (Illumination paraffin (IP) is generally not considered suitable as a clinic energy source.)

There has been some debate concerning the use of LPG versus PV systems for clinic energy supply. Two relatively detailed analyses of suitable technologies for clinic energy supply have

¹² These databases are still in the process of being developed, however, and it is estimated that total clinic numbers are still only known to within about 15% of the actual figure. Surveys are still underway to validate these databases.

¹³ Some line extensions are undertaken outside of utility grid expansion planning - for example, a specific donor may fund grid extension to a particular school in an area where they are active, or the local Department of Works may undertake an ad-hoc extension. The result is often that grid location is not accurately recorded within the utility. The IDT made a planning grant available to the utilities in Venda, Transkei and Bophuthatswana to assist them in determining the exact extent of their grid, but this was only utilised by Venda, who entered the location of their grid onto a GIS.

been undertaken (Cowan 1994; EDG 1993a). These reports found that using LPG for nurses' refrigeration was likely to be cheaper than using PV systems for the same purpose¹⁴. However, the latter report argued that, although LPG is already delivered to clinics for nurses cooking, reliability of supply in many 'deep rural' areas was likely to be inadequate. Also, LPG would do little to improve the nurses quality of life (via improved lighting and provision of a TV/radio power point), which was considered an important thrust in improving rural health care.

Detailed discussions on the system design and costs of different technology options are provided in Appendix B.

7.1.5 The approach to implementation

The implementation of grid and off-grid electrification projects is approached in different ways. In the case of clinics which are to be electrified by the grid, the utilities operating in the areas concerned are asked to submit the costs for the extension of the grid to the IDT. Block funds are made available to the utilities for the extension of the network to batches of clinics, and the utilities manage these projects under a performance contract (IDT 1995c).

The general approach taken to off-grid implementation has been to undertake a pilot project in a chosen area of the country, and thereafter to commence in all regions simultaneously. Clinic PV electrification pilot projects have been undertaken in Venda and Kangwane, for example, and now PV implementation is expanding to all other provinces. However, progress in each province has often been quite different due to constraints in information availability, national and provincial planning and implementation capacity, as well as internal capacity limits of the IDT.

Once the clinics which will be electrified using off-grid technology have been identified in an area, a needs assessment survey is undertaken which involves a visit to each site. This also allows the location of the clinic to be determined accurately. The IDT clinic off-grid electrification programme has therefore been undertaken on an individual clinic basis - each clinic is visited and a needs assessment done before commencing. This has not been the approach in the case of clinics which are grid-electrified, however, which has resulted in some problems.

The clinic PV system is designed based on general clinic system performance requirements (see Appendix B) and on a demand assessment informed by the visit to the site. An open tender process is used to appoint a contractor for each installation, which is done by an adjudication committee established by the IDT. Pre-installation site visits are undertaken to confirm clinic localities and equipment location within the clinic, and to liaise with clinic staff. On completion of the installations, commissioning (or acceptance) tests are undertaken by the project consultant (for example, the EDG). (Details on the tender process and the installation/commissioning of these systems are provided in Appendix B.) User training is a component of the residential PV clinic electrification installation contract, and is undertaken by the contractor.

7.1.6 Maintenance arrangements

The IDT programme makes extensive provision for the maintenance of off-grid systems, as this is recognised as essential to ensure long-term sustainability. As a part of the contractor's obligations, the entire PV system is guaranteed for 12 months, and any component failure during this period not resulting from user-abuse must be made good by the contractor at no cost. The contract also required that PV panels be guaranteed for 10 years. A full set of spares is also stored at the provincial Department of Health offices as a part of the installation contract. The IDT has also established a Joint Maintenance Fund, in which money is deposited for continued maintenance of installed clinic PV systems for the next 10 years. This amounts to approximately R 15 000 per clinic.

Ownership of off-grid clinic energy systems is linked with responsibility for longer-term operation and maintenance of systems, and is therefore a crucial issue. Initially, communities were intended to be the recipients of the IDT funded systems, but since they do not have the resources to maintain the systems, these are to be handed over to provincial Departments of

¹⁴ Estimates of the relative costs varied greatly between the two reports, and placed PV at between 15% and 200% more expensive than LPG used for refrigeration.

Health or Works. (As the Departments of Works are considered to be ineffective in many areas, the Department of Health is often involved instead.)

After the first year, the responsible departments will therefore have to initiate and supervise maintenance contracts with the PV industry, or possibly undertake it in-house. They will be obliged to take responsibility for proper maintenance arrangements if they are to access the Joint Maintenance Fund. However, as all systems installed are still within their one-year guarantee period, ownership of systems has not yet been officially transferred, nor has maintenance been handed over to the relevant departments. The practicalities of how the longer-term maintenance arrangements will work, are therefore still untested. It is not clear at present whether the Departments of Health, or of Works, will take responsibility for this function, and where this responsibility will be located in the institutions. This has hampered preparation for this phase by the IDT, including the training of responsible people.

7.1.7 Progress to date

Overall, the broad IDT target is to electrify about 85% of all rural clinics in the country. The latest figures available from the IDT concerning the status of clinic electrification, and the progress made in the programme are shown in Table 13. It should be noted that these numbers are not static, as both the IDT and the Department of Health are involved in clinic building and upgrading projects. Also, the accuracy of the figures is continually being improved.

Province	Total number of clinics (electrified and un-electrified)	No of major un-electrified clinics prior to IDT programme	% of clinics electrified prior to IDT programme	No of clinics electrified in IDT projects ¹	% of total un-electrified clinics electrified in IDT projects ¹
Gauteng	430	0	100 %	0	-
Western Cape	450	0	100 %	0	-
North-West	290	125	43 %	32	26 %
Northern Province	400	282	71 %	61	22 %
Eastern Transvaal	220	100	45 %	28	28 %
Free State	240	5	2 %	0	0 %
Northern Cape	120	5	4 %	4	80 %
Eastern Cape	450	317	70 %	95	30 %
KwaZulu-Natal	348	77	22 %	32	42 %
TOTAL	2948	901	31 %	252	28 %

1 Includes clinics which have been electrified by IDT as well as current projects

TABLE 13: Status of clinic electrification and programme progress

Source: IDT (1995c)

A detailed breakdown of the number of clinics electrified with the grid, gensets with batteries, and PV systems respectively could not be obtained. However, some figures are available on the numbers of clinics which have been or are being provided with PV systems: By the beginning of 1995, a total of eight clinics in the Northern Province (the Venda area in particular) and 7 in the Eastern Transvaal Province (the Kangwane area) had been electrified using photo-voltaic systems.

In addition, 14 residential clinics in the North West Province are currently being electrified with PV systems, while another 16 may be included in the project. In KwaZulu-Natal 20 clinics are being electrified with PV or PV-genset hybrid systems, some of which are non-residential clinics. This project may be expanded to 26 clinics in total. Furthermore, about 50 residential clinics are to be electrified in the former Transkei in a project which is managed by Eskom's TRI (see below). The project has recently started with a field survey of clinics and hospitals.

7.1.8 *The involvement of Eskom in the programme*

At the outset of the IDT clinic electrification programme, it was expected that Eskom would be centrally involved in both grid and off-grid components of the project. IDT initially hoped to be a funder essentially, with Eskom playing a large part in implementation, and, possibly most importantly, in the longer-term maintenance of off-grid systems¹⁵. Eskom's involvement has been significantly less than expected, however, partly because they did not have a well-defined policy on Remote Area Power Supply (RAPS). As mentioned above, Eskom's TRI has recently been undertaking a more active role in clinic electrification and are likely to take responsibility for clinic PV electrification in the Eastern Cape in the near future. Their involvement in RAPS system maintenance is however likely to remain limited, with provincial Departments of Health or Works taking on this responsibility.

7.1.9 *Recent developments in the IDT programme*

Some recent developments in the IDT programme are discussed in Appendix B. Probably the most important of these is the current move towards integrated service provision within health care, which will include a more integrated approach to energy provision, but is also likely to extend beyond just energy (for example, electricity, water and fencing may be provided by the IDT as a 'package'). This is being made possible by structural changes within the IDT which allow for this sort of inter-programme collaborative planning within the organisation. Energy provision for water supply to clinics has already recently become part of the IDT's programme.

7.1.10 *Problems which have been encountered*

Although one is tempted to think that a programme of the scale which the IDT is undertaking should be well integrated into a coherent national electrification (or even energy) plan, this has not been the case:

- In practice, rural electrification plans have been far from comprehensive and policies and plans in this regard have been changing fast over the past few years particularly. The lack of clarity in this area was not helped by the recent Eskom take-overs of many previously independent utilities involved in rural electrification.
- The IDT energy programme has been seriously understaffed, and there is a limited national and regional capacity to assist in planning and implementation (EDG is one of the few consultancies in a position to be involved in such projects).
- There has been a lack of proper planning information on rural areas which made prioritisation and budget allocation difficult, and Department of Health regional office jurisdictions have changed with the new provincial boundary demarcations, which inevitably delayed planning.

The overall effect of these factors has been that an initial element of pragmatism in programme implementation was necessary, with IDT and others involved often taking a 'learn-as-we-go' approach. Given the constraining factors mentioned above, this approach seems sensible (rather than waiting for a more comprehensive planning framework to be in place before implementation).

Other 'teething' problems experienced in the IDT clinic PV electrification programme are the following:

- The PV industry was often not able to deliver high quality systems initially. While this applies mainly to quality of installation, some untested components (notably DC lights) have also not performed well.
- One supplier with lower overheads could undercut the others and thus be awarded most of the tenders - the process thus excludes much of the solar supplier industry, and thus does not develop industry in general, but rather one or two suppliers. IDT's intended 'Model Clinics' programme may help to involve more companies in the process (see Appendix B).

¹⁵ It was considered that Eskom's extensive technical network placed them in an ideal position to fulfill a technical support function.

- Initially, IDT saw themselves as grant funders, with Eskom and potentially other utilities handling most of the implementation side. However, lack of commitment (by Eskom in particular) resulted in slow progress towards implementation, and IDT therefore became more involved in implementation. This in turn led to capacity problems within the IDT.
- Due to the lack of planning information on rural areas and the IDT's limited experience of the practical situation in many rural areas, unforeseen expenditures often arose. This complicated project finances (e.g. the costs of AC clinic wiring and hospital wiring were initially not anticipated, but have demanded significant proportions of the IDT budget).

A potentially serious problem which is emerging concerns theft. Two PV arrays were recently stolen from clinics in the Eastern Transvaal; one clinic is a new IDT-constructed clinic which was still unoccupied, whereas the other is a fully operational residential clinic with a night watchman. Other PV module thefts were also reported in the area (e.g. from Rurtel systems). It is difficult to see what could be done about this, and it is a concern that such incidents may become more frequent to the extent that they could cripple attempts to improve infrastructure in rural areas.

7.1.11 An assessment of the programme

Some questions have been raised concerning some aspects of the electrification of clinics using PV systems, particularly the costs of commissioning these installations, over-specification in the tender documents, the costly regulatory system used to ensure high reliability (Cowan 1995b; Geerdts 1995), as well as the elaborate tender procedure followed (Morris 1995). However, these have to be seen in the context of the pioneering nature of the programme, as well as the benefits which have resulted from the stringent approach taken (see below).

It can further be argued that the role of the IDT in the planning, co-ordination and implementation of clinic electrification as part of its clinic building and upgrading initiative, is inappropriate as these functions should be performed by the national and provincial Departments of Health, assisted by the electrification industry, and that the current situation therefore amounts to a duplication of institutional structures and functions. The IDT had itself expected to play the role of funder in the clinic electrification process, but had had to expand its involvement when the lack of systematic planning of health services as well as electrification in many of the rural areas (particularly in the former homelands) became evident. However, the planning of health centres, the services which will be provided, and therefore the facilities which are required at these centres, as well as the determining of priorities with regard to the provinces or regions where health services will be improved, and the types of health centres that will be targeted, undoubtedly are the responsibility of the Departments of Health. It appears that these functions are now being assumed by the Health Departments, and it remains to be seen how the current overlap in functions between them and the IDT will be dealt with.

Overall, the impact of the IDT's clinic electrification programme has been significant, and it could already be regarded as a success. Systems installed are generally performing well, and clinic staff and regional health personnel have on several occasions expressed their satisfaction with the results.

A noteworthy achievement is the development of a reproducible procedure for clinic PV electrification which ensures quality systems. While the use of EDG as PV project consultants has probably not been the cheapest or quickest route to follow, it has been effective, and it can be argued that, given the chequered track record of PV installations both nationally and internationally, a very solid engineering approach was justified to make sure that the projects were successful. However, other models for implementation should also be explored, e.g. the industry taking greater responsibility for installation quality, or increased use of Eskom as consultants. Both of these routes are currently being followed by the IDT.

Some positive 'spin-offs' which have arisen from the project are:

- Carefully considered and tested tender documentation has been developed, including detailed system specifications, commissioning processes and maintenance contracts.

- The local PV industry has been exposed to a type and quality of installation which is unique in this country (i.e. their capacity has been developed).
- The testing programme undertaken in conjunction with the tender process, and resulting interaction with the PV industry, has enabled industry to develop a new range of products suitable for this configuration and quality of installation (e.g. higher quality vaccine refrigerators have been developed and new 'solar-bus' regulation systems have been configured).
- A maintenance system has been established which should ensure the sustainability of such electrification initiatives (including the establishment of the Joint Maintenance Fund).
- Detailed information on clinic operation and needs has been obtained, which can inform rural energy and health planning.
- Information on the cold chain operation and practical problems experienced has been obtained.

Nevertheless, the IDT programme is a relatively young one, and while issues concerning sustainability have been addressed, the practicalities thereof have not been tested. In this regard, the IDT intends to undertake a detailed programme evaluation at some stage. Some specific matters that would need to be examined, include:

- the technical durability of systems,
- the technical capacity in the country to maintain and repair systems in remote areas, and the role of IDT fieldworkers in this process,
- the ability and willingness of the Departments of Health or Works to undertake repair and maintenance of systems, and
- the practical functioning of the Joint Maintenance Fund over the longer-term.

7.2 Eskom's schools grid electrification programme

In the past Eskom's involvement in schools and clinics electrification had been of a fairly ad hoc nature, responding to specific requests for assistance to Eskom's Community Development Fund. This activity has since become more formalised (Hambly et al 1994), and has been co-ordinated by the National Electrification Planning department since the beginning of 1995.

Eskom's programme mainly focuses on the electrification of schools, although some clinics are also being electrified. Eskom originally planned to electrify 400 schools and 100 clinics per year as part of its grid electrification programme (Hambly et al 1994). The actual number of schools and clinics which had been assisted in some way through the Eskom programme were 583 in 1994, and the current target for 1995 is about 880 (Hambly 1995). Clinics only form a small proportion of these numbers.

7.2.1 The funding of the programme

Funding for the programme is obtained from a number of sources. Eskom has committed approximately R15 million from the 1995 Community Development Fund towards the electrification of schools and clinics, which represents approximately 35% of the Fund's annual resources¹⁶. In addition, R15.2 million had been donated by the Norwegian Agency for Development Co-operation towards the electrification of schools and clinics (Eskom 1995e). This amount is being administered by Eskom along with its own contribution to this activity, in a special schools and clinics fund. The funds available for schools and clinic electrification in 1995 therefore amounts to about R30 million.

¹⁶ In addition to school and clinic electrification, the Community Development Fund is currently also used for classroom building, provision of educational resources and support for other educational programmes (Eskom 1995e).

The electrification of schools and clinics is also financed through the household electrification programme, as any clinics or schools within the scope of current electrification projects are connected as part of this programme.

Schools have to apply to Eskom for assistance, which may take a number of forms, including the extension of the grid to the school, connecting the school, and/or providing internal wiring (see below). Information on the applications which are received, such as the location and essential features of the facilities concerned, is organised in a national database. Applications are screened in the order in which they are received, using a number of broadly defined criteria.

The total cost of electrifying a school (including grid extension, connection and wiring costs) has been set at about R200 per pupil, although this is generally lower in urban areas (approximately R100 per pupil), and higher in rural areas. The possibility of increasing the maximum amount for rural schools, for example to about R300 per pupil, is under consideration at present (Hambly 1995). The maximum amount paid for the wiring of schools generally amounts to about R2 600 per classroom, depending on the type of wiring used (surface mounted or wall-chased), although up to R3 200 per classroom has been approved (Hambly 1995). Generally all classrooms are provided with fittings for fluorescent lights, as well as two wall sockets. Apart from light fittings which are included in the cost of internal wiring, no funds are made available for the purchase of appliances, as this is the responsibility of the provincial Departments of Education (see below).

A process of review is currently underway with the aim to improve planning and accounting procedures, establish clear criteria for the approval of projects etc. (Hambly 1995).

7.2.2 *Electrification projects included in the programme*

Eskom's involvement in the electrification of schools and clinics takes a variety of forms, which can be categorised as follows:

- The electrification of schools and clinics in areas which have already been electrified.

There currently exists a 'backlog' of clinics and schools which had not been connected when the areas concerned were electrified. These connections are given a high priority at the moment. Eskom's schools and clinics fund is used to pay for the service connection as well as internal wiring. Eskom also funds the electrification of such schools by municipalities, while schools on commercial farms are only included in the programme if the farms had previously been electrified (Hambly 1995). During 1994 a total of 319 schools and 19 clinics were electrified in this way (Eskom 1995b).

- The electrification of schools and clinics as part of new electrification projects.

Although Eskom's grid extension programme is aimed primarily at the electrification of households, there has been some effort at ensuring that schools and clinics within the areas earmarked for electrification are included in projects. Responsibility for ensuring that this occurs lies with the regional offices responsible for project planning and implementation. It is only in this year that this responsibility has been allocated to individual employees in the regions. In these cases, the project must cover the cost of connecting the school or clinic, while the schools and clinics fund will pay for internal wiring on application. During 1994 some 243 schools and 12 clinics were electrified by Eskom in this way (Eskom 1995b).

- The extension of the grid to schools and clinics.

Where a school or clinic lies outside the scope of an electrification project, applications to the schools and clinics fund for a limited line extension to the site will be considered. The extension of the grid to schools and clinics is generally not funded by Eskom, however. In cases where clinics are located within a distance of about five kilometres from the grid, funding has been obtained from the IDT clinic electrification programme (see above). The IDT generally covers the 'un-economic' portion of the capital cost of extending the grid to a settlement where there is a clinic, which can be interpreted as being sufficient grant

funding to bring the cost per connection to within Eskom's limits (currently set at R4 000 per connection for rural areas).

- RAPS electrification of clinics and schools.

As a general rule, schools which are located more than 5 km from the grid, and where the grid is not expected to reach in the next five to ten years, are referred to TRI for the provision of RAPS systems (see below).

7.2.3 *Tariff and metering/payment options*

No single policy concerning tariffs and the metering/payment of electricity consumption by schools and clinics is applied at present. Tariff options for newly electrified schools and clinics include the Homelight, Homepower and Landrate tariffs (see Appendix A). Both prepayment and conventional metering systems can be used, although the availability of these options depends on the service infrastructure in the areas concerned. For example, conventional metering would only be a possibility in areas where meter reading can be done by Eskom. Generally these decisions are made separately for each project (Hambly 1995).

It appears that schools often prefer conventional meters, as funds may not always be available to purchase electricity tokens (Hambly 1995). In other cases, prepayment metering is preferred in order to keep expenditure on electricity under tighter control of the principal. In addition, different departments also have different preferences, in accordance with the nature of budgetary and financial management procedures.

7.2.4 *An assessment of the programme*

It is difficult to assess the extent to which the programme has been successful to date: in the first place, no clear objectives exist for the programme, and secondly, no impact assessments have yet been conducted at schools which have been electrified through the programme. A few ad hoc comments can be made in this regard, however.

The schools electrification programme does not form part of a larger initiative to upgrade facilities and improve education at schools, as is the case with the IDT clinics electrification programme. No clarity exists on the type of facilities requiring energy which are needed and will be provided at different schools, for example, kitchens for home economics classes, audio-visual equipment, and security lighting. Provincial Departments of Education are generally responsible for providing electrical equipment at schools, but it appears that little is being done in this regard (Hambly 1995). Given these conditions, it is unlikely that the quality of education will benefit significantly from the electrification of schools. Furthermore, as mentioned above, schools are in some cases not able to purchase electricity tokens, which would further restrict their ability to utilise the electricity supply.

Although the utilisation of schools for night classes, for example as part of adult education programmes, is generally seen as an important reason for the electrification of schools, it is not clear to what extent electrified schools are being used for this purpose.

In some cases *clinics* which have been electrified through the programme, have not been provided with internal wiring, while medical equipment has also not been provided by the Department of Health concerned (Morris 1995). As a result, such clinics have not been able to utilise the electricity connection.

7.3 *TRI's schools off-grid electrification programme*

During 1994 the Non-grid Electrification group in Eskom's Technology Research & Investigations (TRI) launched a schools electrification programme which will utilise off-grid technologies (Eskom 1995a). It has undertaken to electrify 1000 schools by March 1996. This programme will be discussed here very briefly, but it should be recognised that the approach taken and procedures followed, are still being developed, and could therefore change significantly in the future.

7.3.1 *The funding of the programme*

Funding for the programme is expected to come primarily from foreign development assistance, some of which will be channelled through the RDP fund. In particular, the French

government together with some French companies have shown an interest in funding about 600 off-grid systems providing electricity to schools as well as other community facilities in a number of provinces (Cowan 1995b). This will depend on the outcome of feasibility studies in these areas, as well as the approval of, and possibly co-funding by, the RDP office. In the short term, funding has been obtained from Eskom's Community Development Fund, which has amounted to about R2.5 million to date (Buttle & Lawrence 1995b).

7.3.2 *Progress to date*

A pilot project has been conducted in Jojweni in the former Transkei, which was funded by Eskom's Community Development Fund (Eskom 1995a). This project included the installation of PV systems at the school, clinic and nurses' quarters. The total cost of the project was about R115 000, of which about R40 000 was for the school, R50 000 for the clinic and R25 000 for the clinic staff quarters. Provision was made for lighting in three classrooms and the staffroom at the school, as well as AC outlets for the use of television, video and overhead projectors. At the clinic and staff quarters provision was made for lights, a sterilisation unit, a refrigerator and an AC outlet for television.

A further 20 schools and one clinic have also been electrified in the Northern Cape (Cowan 1995b), while 12 schools and 10 clinics are currently in the process of being installed in the Free State (Buttle & Lawrence 1995). Funding from the Community Development Fund has been obtained for some schools in KwaZulu/Natal, but all other off-grid schools projects are pending a decision on funding from the RDP fund.

7.3.3 *The approach to electrification*

Much attention has been given to date to the establishment of a procedure for the off-grid electrification of schools and clinics. Some elements of the proposed procedure, which have not yet been finalised, can be summarised as follows (Buttle & Lawrence 1995; Cowan 1995b):

- Schools (and clinics to a lesser extent) which could be included in the programme will be identified in liaison with the government departments concerned.
- Application will be made to the RDP for funding, possibly for 50-100 schools and clinics at a time.
- Consultation with the communities where the facilities are located, will start once funding has been secured. (The possibility of starting this process earlier is being considered.)
- Tenders will be called for, and a contractor will be appointed for each project.
- Large contractors will be expected to train local entrepreneurs to install and maintain off-grid systems, thereby building local capacity to perform these functions in the future.
- TRI will commission the systems after installation, and monitor the maintenance programme.
- Maintenance will be conducted by provincial Departments of Public Works or by local contractors.

Although maintenance arrangements have not yet been finalised, it appears that TRI will be following a very different approach from that which has been established by the IDT (see above). For example, the provincial Departments of Public Works are currently expected to provide for maintenance costs in their annual budgets. The intention is to obtain a written undertaking from the departments concerned that they accept responsibility for the maintenance of systems.

The composition of the tender document and the tender procedure followed also seem to differ substantially from the way these matters have been dealt with in the IDT programme. Some concern has been expressed about the tender procedure, particularly the lack of openness in the procedure used to date, while the tender document is also seen as lacking in detail, thus failing to ensure that systems will be of an acceptable quality (Morris 1995).

Another concern which has been raised, is that system design may not be adequately informed by potential energy requirements at schools (Morris 1995). It appears that only limited direction has been provided by the Department of Education in this regard, while

needs assessments undertaken as part of the programme to date have been of a fairly limited nature. Currently provision is made for lighting in three classrooms, the staffroom and principal's office, as well as one of two power outlets for a television, video, overhead projector etc. The average cost per installation, excluding electrical equipment, has been estimated as between R40 000 and R50 000 (Buttle & Lawrence 1995). However, it is uncertain whether audio-visual and other equipment will be made available to schools in the future.

7.4 Limitations of the current programmes

In conclusion, some general observations can be made about these programmes. It is evident that major differences exist between the various programmes. The IDT clinic electrification programme, on the one hand, is located within a fairly integrated development initiative, taking a multi-sectoral approach to the improvement of health services in rural areas of South Africa, of which the provision of energy forms only one component. Clinics have also been upgraded and provided with the necessary equipment at the same time as energy is provided, to ensure that the quality of the service is improved.

The schools electrification programmes by Eskom, on the other hand, focus particularly on the supply of electricity to schools. This appears to happen in isolation, rather than being part of a broader programme to upgrade education facilities. It is therefore likely that the impact of schools electrification on the improvement of educational services in rural areas will be very limited in the short term. However, even in the longer term the impact may be very limited, as other constraints to improving education are likely to be of much greater consequence.

Another limitation of the current programmes aimed at electrifying community facilities, is the very specific focus on clinics and schools. Two other important services in rural areas, public lighting and water supply, are not adequately provided for in current electrification programmes. Public lighting is generally not provided in rural settlements, mainly because there are no authorities which can take responsibility for the payment of such services. Furthermore, no specific initiative to co-ordinate water supply planning with electrification is currently underway.

8. Electrification of small-scale agriculture

The current status of the electrification of small-scale agriculture in South Africa will be discussed here very briefly. This is possibly the least developed aspect of electricity provision in rural areas at present. Attention will be focused on current initiatives by Eskom, as the main supplier of electricity to the commercial agricultural sector in South Africa, and the likely supplier in the former homeland areas. Some attention will also be given to the broader context of small-scale agricultural development in South Africa.

8.1 The current approach taken by Eskom

Meeting the electricity needs of the agricultural sector, including the provision of advice and assistance concerning the utilisation of agro-electro-technologies, is the responsibility of Agrelek, Eskom's advisory service to agriculture. Agrelek currently has a network of about 80 advisors nationally, who have mostly been serving the large commercial farming sector comprising mainly 'white' farmers. Experience with small-scale agriculture has mainly been confined to KwaZulu-Natal where Agrelek has been assisting non-governmental organisations (NGO's), which support small farmers, for a number of years.

A very different situation is now unfolding, with government policy emphasising the development and support of small-scale agriculture. Since the beginning of 1994 Agrelek has also been receiving enquiries from small-scale farmers. In response, Agrelek has launched the Small and Medium Scale Farmer (S&MSF) Initiative with the short-term objective to 'identify feasible pilot projects for rural enterprise electrification whereby Agrelek [will be] able to develop and test strategies which will assist the target sector' (Combrinck & Simelane 1994), including the development of 'local level participatory Integrated Energy Planning (IEP) methodology, and ... appropriate and innovative agricultural End Use Electro-technologies (EUE's)'. A national and a few regional co-ordinators have been appointed to this programme. The establishment of pilot projects is receiving priority, and a number of feasibility studies have been done to date. However, progress is severely hampered by a lack of financing, and to date limited projects have been implemented by Agrelek (Combrinck 1995). Agrelek also convened two national meetings during 1994 as part of their National Energy Technology Development Initiative, where a range of players from the agricultural and energy sectors were present (Williams 1995).

There are obvious and significant differences between the circumstances and needs of Agrelek's traditional target group and small-scale farmers, including the scale of operations, access to resources, technologies used etc. A major reorientation within Agrelek will therefore be necessary to serve the latter group effectively. For example, new advisors will need to be appointed to deal specifically with small-scale farmers, as the current advisors are occupied in servicing the needs of the commercial farming sector (Combrinck 1995). Another factor appears to be that attitudinal problems are being experienced with some of the current advisors (Simelane 1995). Plans are underway to appoint additional Agrelek advisors to focus specifically on the needs of the small-scale agricultural sector. The objective is to equip these advisors to provide a broader energy service rather than just an electricity-focused service, particularly in the shorter term. Particular emphasis will also be placed on promoting Agrelek's services to small-scale farmers by means of the radio. These services include training (e.g. management training) opportunities, and advice on available technologies.

8.1.1 Limitations of the current approach

However, the current and envisaged changes in Agrelek are inadequate to ensure that the electrification of small-scale agriculture will be dealt with in an appropriate manner - for that both reorientation and reorganisation within Eskom will probably be required (Simelane 1995). The first problem is that agricultural needs are given a low priority in Eskom's current rural electrification programme. This is probably understandable, given the fact that there is no national programme in place as yet to develop and support small-scale agriculture, and the

underdeveloped state of this sector at present (see below). Nevertheless, it can be contrasted with the emphasis which had been given to agricultural purposes in other programmes, e.g. in India (May et al 1994). The low priority given to small-scale agriculture in Eskom also stems from the perception that the costs of electrifying small-scale farmers are likely to be prohibitive. This conviction prevents the development of creative approaches and solutions to this matter within Eskom (Simelane 1995).

Secondly, the way in which the departments in Eskom responsible for this sector are structured, does not reflect the different nature of small-scale agriculture compared to commercial agriculture. The system of using Agrelek advisors as the primary contact with farmers was probably appropriate in an environment where the primary need for energy/electricity in the often sparsely populated commercial farming areas was for agricultural purposes, while the domestic needs of farmers (and in some cases, farmworkers) were met 'on the side' (although this has also limited the extent of farmworker electrification, as discussed in chapter 6). In this context the role of Eskom's electrification departments has been mainly restricted to the implementation of electrification projects which had been initiated and planned under Agrelek's supervision.

Most small-scale farmers, on the other hand, are presently located in relatively densely populated areas in the former homelands where the primary use of energy is for domestic purposes. In many cases the provision of electricity for agricultural purposes may therefore need to form part of an electrification project in a largely residential area. If particular energy needs of small-scale farmers are to be met through the current electrification programme, some form of restructuring of functions within Eskom would thus be required to ensure the proper co-ordination and integration of electrification planning generally and the electrification of small-scale agricultural activities in particular.

There are indications that a shift is taking place, e.g. Agrelek advisors operating in some of the former homeland areas report to the SACS managers responsible for those areas (Simelane 1995). However, although it is generally accepted that agricultural potential and specifically the additional loads¹⁷ which may result from the electrification of agricultural activities need to be considered in electrification planning, this is not done at present. This is at least partly because the information required for planning of this nature is not available at present. One of the questions which will need to be addressed, concerns the department of Eskom which should take primary responsibility for small farmer electrification. At present there seems to be general agreement in Eskom that this should remain with Agrelek.

A third matter which is hampering progress in this area, concerns the financing of the electrification of small-scale agricultural activities. Farmers are generally provided with electricity on the Landrate tariff (see chapter 6), which is costly to the farmer as only 200 m of line is currently included in the tariff, while the rest of the capital costs have to be paid by the farmer in the form of a monthly land rental. This policy may need to be reviewed to make electricity more accessible to small farmers. However, it should be pointed out that the tariff already effectively provides a subsidy to a large percentage of farmers using less than 1000 kWh per month (McDougall 1995). It is further uncertain whether it would be feasible or advisable to increase this subsidy as pertaining to small-scale farmers. This situation is compounded by the fact that credit is not yet widely available to them.

8.2 Electrification and agricultural development

The obstacles which prevent the needs of the small-scale agricultural sector from being addressed adequately by Eskom, are related to problems of a broader nature in the agricultural sector, particularly the absence of a co-ordinated national programme to support and develop small-scale agriculture. Although a number of initiatives have been undertaken in the sector, such as the land reform pilot projects co-ordinated by the Department of Land Affairs, and the Broadening Access to Agriculture Thrust (BATAT) which was launched by the Department of Agriculture during 1994, these have not yet been translated into a broad-

¹⁷ These additional loads may prove to contribute significantly to improving the load factor and the general viability of some rural electrification projects.

based programme. The absence of such a programme hampers the development of a policy and programme for the electrification of small-scale agriculture, particularly as the following matters have not been adequately addressed:

- A national policy framework concerning agricultural development and energy service provision, which defines the particular role of electrification in agricultural development in relation to other forms of energy, and in order to meet particular rural development objectives.
- The absence of an institutional framework for the provision of support services to small-scale farmers, including support pertaining to the utilisation of energy, including electricity, and in particular the roles of different state departments in this regard.
- The lack of planning information concerning small-scale agriculture, including the number of small-scale farmers currently involved in different activities in particular regions, as well as future plans concerning development in this sector.
- The lack of access to credit amongst small-scale farmers.

Some progress has been made with developing an understanding of the energy needs of the small-scale agricultural sector, and the potential role of electricity in meeting these needs (May et al 1994; Auerbach & Gandar 1994). Generally the importance of conducting the electrification of small-scale agriculture within broader rural electrification and rural development programmes has been emphasised. However, little progress has been made with the development of a programme of support concerning energy services to small farmers, while the division of responsibilities between the Departments of Agriculture at national and provincial level, as well as different players in the energy sector, is not clear.

9. Discussion and conclusions

This paper has attempted to provide a broad overview of current experience with respect to rural electrification in South Africa, supplemented by some detailed discussion of aspects on which information has not been readily accessible to date. Clearly a lot of experience has been gained in this area, which is informing debate, critical review of current approaches, and future planning. In this concluding chapter, a number of issues concerning rural electrification which are regarded as being of particular importance, will be highlighted.

9.1 A rural development framework for rural electrification

The absence of a national rural development framework for rural electrification, which sets out the role of electrification in rural development, as well as the specific development objectives of rural electrification programmes, and with this identifies priorities for rural electrification on the basis of development priorities, is very evident from this review. The IDT clinic electrification programme is the only exception to this, as this programme was conceived and planned as part of the IDT's broader rural development activities.

The overall aim of the IDT clinic electrification programme has been the improvement of health services in South Africa. Following from this, electrification or energy planning has been conducted with the aim to meet specific needs in the health sector, such as vaccine refrigeration to sustain the cold chain. By comparison, no similar specific objectives have been formulated for the national electrification programme, or the schools and clinics electrification programmes conducted by Eskom. These programmes are essentially electrification programmes and not development programmes. The aims have been defined in terms of numerical targets, and not in terms of particular development needs. For example, schools are being electrified without a clear understanding of the facilities which will realistically be provided to these schools in the future. In the case of off-grid electrification this is of particular concern, as the system design load can have a significant impact on the costs of an installation.

In line with its emphasis on the needs of the poorest in society, the IDT's focus in rural electrification has been on clinics which provide an essential service to all people, and therefore tend to spread the benefits of electrification more equitably amongst all residents of an area as compared to household electrification (Thom 1994).

By comparison, the focus of the current national electrification programme is on the electrification of households, and, in rural areas, specifically households in the former homelands. In addition, schools and clinics have been identified as priorities for rural electrification. It is not clear *on what grounds* these have specifically been identified as priorities, and why farmworker households, for example, or water supply in rural areas, or small-scale agriculture have not been given similar or greater priority. Certainly the priorities have not been established by Eskom alone, as the national government has emphasised the electrification of schools and clinics in addition to household electrification. One could question the priority placed on schools electrification in particular, as electrification is probably one of the least critical inputs to improve the quality of education in South Africa. On the other hand, the virtual absence of small-scale agricultural and water pumping needs from current programmes probably need to be reviewed urgently.

9.2 Co-ordinated rural development and electrification planning

It is further evident from this review that very little effective co-ordination between rural development and electrification planning is taking place at present. Again the IDT has been able to overcome some of the obstacles in this regard. It has taken a fairly integrated approach to the improvement of health services in rural areas, of which the provision of energy forms only one component. Clinics have thus been upgraded and provided with the necessary equipment at the same time as energy has been provided, to ensure that the quality of the service is improved. The IDT has also been constrained by inter-sectoral barriers, however -

for example, it has only recently broadened its involvement with clinics to include water supply.

The national electrification programme, on the other hand, is not located within an integrated development programme. It is mainly driven by the electricity distribution industry, and Eskom in particular. Although attempts are made to involve other parties concerned, such as the Departments of Health and Education in the electrification of schools and clinics, the electrification programme is much further advanced than programmes to improve services in some other sectors, with the result that very little co-ordinated planning is taking place. Small-scale agriculture in particular is at danger of being marginalised by the current electrification programme because of the underdeveloped state of planning for this sector. This situation is compounded by the fact that government structures to facilitate development co-ordination at provincial level are still in the process of being established. In this context the appropriateness of national electrification targets which have to be met irrespective of progress in other development sectors, needs to be questioned.

9.3 An integrated energy planning framework for rural electrification

The absence of a national policy framework to facilitate integrated energy planning in South Africa is also evident from this review. For example, planning with respect to off-grid electrification is hampered by the lack of clear national criteria for identifying areas which are to be electrified by the grid. At present the only criteria which can be used, are the distance of a settlement from the current grid and whether a settlement is included in plans to extend the grid, while information on these matters are often inadequate. The IDT, being concerned with meeting the energy needs of clinics in a cost-effective and sustainable manner, has developed a simple set of guidelines for the selection of particular supply options, including the use of LPG, RAPS systems and grid electrification.

A recent aspect of Eskom's rural electrification policy has been a commitment to 'integrated energy planning', whereby other supply and demand strategies are considered as alternatives or complements to electrification (Eskom 1995b). This is gaining particular importance in the light of the proposals to provide load limited supplies in a significant percentage of the areas which will be electrified in the future. However, it is unlikely that such an approach could be driven successfully by an organisation aligned with a particular energy carrier, as is the case with Eskom.

It is generally accepted that electricity will not meet the bulk of energy needs in rural areas in the short to medium term, and other programmes have been initiated to address broader energy needs, such as the social forestry programme presently funded and managed as part of the IDT's Rural Energy Programme. However, energy service provision in rural areas is still characterised by a piecemeal approach, and it is unlikely that energy needs and problems will be met in a comprehensive and consistent manner unless a national policy and institutional framework for integrated energy planning is put into place (Thom et al 1995).

9.4 An institutional framework for electrification planning

Another significant gap which is evident from this review, is the lack of an institutional framework for electrification planning, with clear roles for different players in this field, including government structures at national, provincial and local levels. The role which local government in rural areas could play in electrification planning and development co-ordination generally, requires specific attention (Thom et al 1995).

At present electrification planning for rural areas is essentially conducted by the IDT and Eskom, both of which are public sector institutions with very specific missions. The IDT was formed to address poverty and the needs of the poorest, for which it utilises grant funding from the state. Eskom, on the other hand, is a public utility which has been charged with the cost-effective supply of electricity to South African consumers, and finances itself through the capital and money markets.

Eskom in particular, being responsible for two-thirds of the national electrification programme, is planning what is in fact a government-sanctioned and highly subsidised national programme, and is effectively developing national electrification policy for rural

areas, with very little direction from national government. However, as reflected in the discussion above, Eskom is not an appropriate institution to take responsibility for rural electrification policy and planning. The utility itself has indicated that it expects of government to provide a framework for rural electrification planning. However, in the absence of the necessary institutional and regulatory arrangements which will enable government to set rural electrification policy and to oversee its implementation, some vital decisions are being made within Eskom - for example with regard to targets for reducing capital costs, which could have far-reaching implications for rural electrification in the future.

Finally, a crucial aspect that needs to be considered, concerns the implications for rural electrification planning of a decentralised approach to development planning in rural areas, and particularly the implications of such an approach for the way in which the financing of rural electrification projects is structured (Thom et al 1995). For example, it may be necessary to place more control over the financing of electrification projects at a local level.

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A1. Eskom's connection and tariff policies

This discussion will focus primarily on Eskom's connection and tariff policies, as the vast majority of rural electricity users are, and will probably continue to be, Eskom customers. As tariff policies and pricing levels in the entire distribution industry move towards conformity, more distributors are likely to adopt Eskom pricing practices.

As the distribution activities of Eskom have grown with the implementation of the electrification programme and the absorption of other distribution authorities, pricing policy for small users has grown in importance. In the past, Eskom's preferred practice has been to attempt to avoid cross-subsidisation between tariff categories (with the important exception of rural and prepayment tariffs), but to allow cross-subsidisation within tariff categories. The latter has arisen largely as the result of (1) pooling resources in order to promote electrification on commercial farms; (2) the use of national tariffs despite the additional costs arising from increased transmission costs in remote areas and in the southern parts of the country; and (3) the impracticality of installing maximum-demand meters for small users.

Pricing policy is designed to realise a real rate of return of 6% p.a. over a 15-year period (in fact Eskom uses a nominal rate of return which is revalued as estimates of inflation change). This return should be realised on both recurrent and capital expenditure costs. However, two tariffs generally fail to realise this - the Landrate ('D') and Homelight ('S') tariffs - and losses are sustained by Eskom on these two customer categories. These losses are covered by revenue from other customer categories. Each of these subsidised tariffs is discussed in more detail below.

A1.1 Eskom tariffs

The table below summarises Eskom tariffs. All tariffs are subject to VAT, and any figures quoted include 14% VAT, unless specifically stated.

Tariff name	Old name	Application
Standard rate	A & F	Large customers with constant demand pattern.
Nightsave	E	Large customers with night-time loads.
Time-of use	T1, T2 & Ruralflex	Time-of-use tariffs for large urban customers (Maxiflex), smaller urban customers (Miniflex), and 3-phase rural customers (Ruralflex).
Business rate	B	Small businesses in urban areas.
Landrate	D	For agricultural & domestic supplies in rural areas.
Homepower	C	Medium usage residential customers (1φ or 3φ).
Homelight	S	Single phase supply to low usage residential customers.

TABLE 14: Current Eskom tariffs
Source: Eskom (1995h)

For all large-user and time-of-use tariffs, the demand and energy charges are subject to a transmission surcharge, depending on the distance from Johannesburg. For distances between 300 km and 600 km a 1% surcharge is levied; for distances between 600 km and 900 km, there is a 2% levy; and 3% is levied on distances greater than 900 km. However, these surcharges only recover a portion of the additional costs of long-distance transmission (Eskom 1995h).

Connection fees vary between tariff categories. Single phase residential tariffs are charged a nominal connection fee of R45. However, Homepower customers are expected to pay for the

meter box or pay an additional R445. Connection fees for other categories vary between R500 and R3,800. A new rural connection on the Landrate tariff must pay a connection fee of R1,300 or R650 for 3 phase and single phase supplies respectively (Eskom 1995h).

In rural areas, customers have the option of the following tariffs: Homelight, Homepower, Landrate, or Ruraflex. The Homelight and Homepower tariffs are only available in areas designated by Eskom for residential tariffs, which generally covers settlements of 10 or more houses.

Eskom's price compact aimed to reduce the real cost of electricity by 20% between 1992 and 1996 (Steyn 1994). To date price increases are such that this target is likely to be reached. Eskom's current commitment to the RDP is to reduce prices by 15% between 1995 and 1999 (Els 1994). However, after 1996, annual price increases are planned to be only one or two percentage points below inflation. South Africa's average electricity price is currently one of the lowest in the world.

A1.2 Landrate (formerly 'D') and Ruraflex

The structure of the Landrate tariff, developed primarily for commercial farmers, includes a basic charge set according to the installed capacity, an energy charge which is divided into a high rate for consumption below 1000 kWh/month and a low rate for additional consumption, and a monthly rental calculated on a portion of the capital investment to bring the line to the supply point.

Prior to 1982, the customer was required to either pay the full costs of providing the supply point, or to pay a monthly rental on the line calculated to cover the full cost of Eskom's capital investment (over 15 years). In response to requests from South African Agricultural Union (SAAU), Eskom adjusted the tariff so that a portion of the line extension cost would be covered by the tariff, i.e. a portion of the capital investment would be shared within the tariff category. In 1985 the arrangements were adjusted so that a full 2 km of new line plus the cost of the transformer would be covered by the tariff. However, the tariff adjustments were inadequate to fully recover these costs and customers taking advantage of this offer were effectively being subsidised from Eskom's full customer base. In 1989 the arrangements were again adjusted to reduce the 'free' extension to 200m of line plus a 25 kVA transformer (McDougall 1994).

Although these adjustments have effectively reduced the level of cross-subsidy, revenues from consumers on the Landrate tariff using less than 1000 kWh per month are inadequate to cover costs. The cost of 200m of line and transformer are R19,000. Consumers using 1000 kWh per month generate surplus revenue above operating costs of R95/month, which is sufficient to repay R19,000 over 25 years. However, 40% of the existing 26,000 Landrate customers use less than 1000 kWh and are effectively cross-subsidised from other customers. Those using above 1000 kWh generate sufficient revenue to cover the costs of supplying them, but do not generate enough surplus to cover losses on lower level consumers (McDougall 1994).

The fact that many Landrate consumers are subsidised (particularly those who took advantage of the 2 km free line extension) has implications for the supply of new customers from lines built to provide Landrate customers. Many Landrate customers still pay a monthly rental on their lines. In general, a 'fair-sharing' principle is applied so that any new customers feeding from lines with other customers paying monthly rentals, are expected to contribute equally to this rental. However, in cases where customers received 2 km of line extension for free, this cost is taken into account before any reductions in their monthly rentals can be negotiated (McDougall 1995).

The fair-sharing arrangements are relatively straight-forward where new Landrate customers are connected. However, it is slightly more complicated when new Homelight customers are picked up. These customers do not pay monthly rentals and so any negotiated reduction in a Landrate customer's monthly payment directly affects Eskom revenue. In these cases, an additional load of every 100 kVA is taken to be equivalent to one new customer and used to calculate reductions. However, this is only implemented after the considerations related to the 2 km of free line are taken into account. In cases where a new customer opted to pay cash for

line extensions instead of monthly rentals, no cash refunds can be negotiated (McDougall 1995).

The Ruraflex tariff is used for Eskom's three phase rural customers who can shift their load to off-peak periods.

A1.3 Residential tariffs: Homepower and Homelight

The other subsidised tariff is the Homelight, formerly known as the S tariff. This has generally been used with pre-payment meters, but can be used with conventional meters. The tariff is structured as an energy charge with no monthly fixed charge. Two variations of the tariff are available: Homelight 1 is currently set at the relatively high level of 25,81c/kWh and, for high levels of consumption, should generate sufficient surplus revenues to cover any new investments in the distribution system. Homelight 2 has an energy charge of 22,07c/kWh and is used where Eskom has not had to provide the local reticulation system (excluding the service connection costs).

Given the historic costs of connecting and supplying new Homelight customers, Homelight 1 is sufficient to cover all costs when consumption is 350 kWh/month (McDougall 1995). Given that average consumption levels to date are in the region of 80 kWh/household per month (Eskom 1995g), the vast majority of these customers are cross-subsidised from other customer categories. Given the structure of the tariff, the extent of the cross-subsidy depends on consumption growth over time. If the average sales per customer is 250 kWh/month, then the subsidy per customer is in the region of R3/month (Schoeman 1995a). It is estimated that with this consumption level, a 15% reduction in the capital cost per connection would eliminate the necessity for this subsidy (Schoeman 1995a). The three areas of uncertainty in estimating the level of subsidy are (1) the load growth over long time horizons; (2) the extent to which the current high levels of non-technical losses can be reduced; and (3) opportunities to reduce investment costs per connection.

Given that the Homelight tariff is subsidised, Eskom is considering adopting the policy of providing Homelight consumers with current breakers to limit the load. The proposals are to provide a 20A supply for customers using less than 200 kWh/month; 40A for those using up to 400 kWh and 60A for higher consumption customers (McDougall 1995). At present all customers are provided with a 60A supply. The motivation for installing current limiters is the growth in maximum peak demand as a result of Homelight consumers, and the implications this has for supply costs. Another option currently being considered and experimented with is the use of 2.5A load limited supplies (Steyn 1995).

The use of the Homelight tariff has largely been associated with prepayment meters; and the Homepower tariff with conventional billing systems. However, Eskom policies allow for either residential tariff to be used with either metering system; and Homepower customers with consumption levels below 552 or 1312 kWh/month would receive lower bills by switching to Homelight 1 or 2 respectively (McDougall 1995). Although a straight-line tariff can easily be implemented with a conventional meter, the application of the Homepower tariff with a prepayment meter presents billing difficulties and is unlikely to occur often. The charge to change tariffs is R45, but the charge to change metering systems is R650 for single phase and R1000 for three phase supplies (Eskom 1995h).

A1.4 Remote area tariffs: flat-rate limited load tariff and RAPS tariff

Eskom is currently considering the introduction of a flat-rate load limited tariff for use in very remote areas where demand is likely to be low. The reasons for this are to reduce installation costs (prepayment meters cost approximately R600 to install), to avoid the necessity to provide a card-vending service in these remote areas, and to limit the contribution to peak load that these presumably heavily subsidised customers might have.

Although a RAPS tariff policy was developed some time ago, it has only very rarely been used. It is unclear whether this is due to the high cost of the tariff (maintenance charges are high), or a lack of skills or enthusiasm for the tariff among distributors. Some installations using this tariff exist on the Botswana border (McDougall 1995). Although one of the RAPS tariff options is specifically designed for the installation of photovoltaic systems at institutions

such as remote schools and clinics, it has not been used as part of Eskom's schools and clinics programme.

A1.5 Public lighting

When Eskom provides a supply for, and maintains street lighting, charges are made to the relevant local authority. A capital charge of 1.455% of the capital cost is charged every month for 15 years and a connection fee of R45 per pole or highmast is charged. Maintenance charges are different for streetlights and high-mast lights and are billed on a monthly basis (R6.85 per streetlight or R160 per high-mast per month). Energy charges depend on whether the lights are used at night or on a 24 hour basis. The option exists to base the energy charges on a metered energy basis, or a flat rate per installed 100W (Eskom 1995h).

In general, Eskom's policy is to only install public lighting where there is a local authority willing to pay for the installation, maintenance and operating costs. In many newly electrified areas and particularly in rural areas, such an authority with adequate funds at its disposal does not exist, and public lighting is not installed. In a few cases, lights have been installed but have not been switched on.

A1.6 Tariff policies for farmworkers, schools, clinics & enterprises

General policies for farmworker electrification are dealt with elsewhere in this document. Eskom encourages farmers to connect workers' houses through the farmer's supply, and to issue one bill for the entire farm. This will usually be on the Landrate (formerly 'D' tariff). However, if the number of houses exceeds ten, then the option exists to install meters at each house. If there are fifty or more houses, then the project may be treated as a standard electrification project and the farmer need not be formally involved in the project at all (McDougall 1995).

Schools and clinics are generally charged on Homepower or Homelight tariffs. In some cases, the choice between these two may be restricted by practices in the area, or constrained by financial systems operational in provincial government departments.

Businesses in urban areas generally use the Businessrate tariff. However, many small enterprises in newly electrified areas are installed with prepayment systems and are charged Homepower tariffs.

A1.7 Tariffs for remote telecommunications sites

As Telkom and the cellular networks extend services through the country, there is a need to power remote stations. These sites generally require very low power levels (consumption of less than 200 kWh/month), but the institutions involved are prepared to pay for the often substantial cost of providing a supply. Given that the Landrate tariff contains a subsidy at low consumption levels, a variation of this tariff has been developed for these cases.

Landrate Dx is to be used for Telkom 'Rurtel' rural telephone sites, traffic monitoring systems and telecommunication repeater sites (Barnard & McDougall 1995). The tariff allows new users on this tariff to receive the 200m of line extension and transformer for free. The cost of additional line extension must be paid by the customer up front and in full and a connection fee of R650 is charged. If the new connection uses existing circuits with monthly rentals, fair-sharing is applied and the new customer must pay the total capitalised monthly rental in cash. There is a monthly fixed charge of R210.39, but no energy charge is made. If the monthly consumption exceeds 200 kWh/month, then a penalty must be paid.

It is possible that as many as 10 000 new connections may be made using this tariff. The agreement between Eskom and the new user also states that electrification projects may use any lines paid for under this arrangement without any compensation to the original user. The only exception is where a competitor (i.e. another telephone service company) wishes to use the line, in which case fair sharing is applied. In this way, the extension of the grid network in rural areas by telecommunications companies presents opportunities for low cost rural electrification.

A2. Details of the IDT clinics electrification programme

The experience which has been gained with the electrification of clinics during the IDT clinic electrification programme, particularly with respect to the use of PV systems, will be discussed here in some detail. Particular attention will be given to the technical options and design criteria which have been used, the tender process used in the PV electrification component, and the maintenance systems which have been put into place. Some discussion will also be provided of recent developments in the IDT clinic electrification programme.

A2.1 Grid electrification of clinics

A2.1.1 Demand assessment

For grid-connected clinics, no detailed demand assessment is generally undertaken and, as grid supply is typically provided in a number of standard steps (25 kVA is usually the smallest transformer provided, thereafter 50 or 100 kVA transformers can be installed if necessary), it seems that there would be little point in undertaking a detailed demand assessment to fine-tune clinic kVA needs.

A2.1.2 Technology used

Normal three-phase bare overhead extensions with 25 kVA transformers are typically used. Where other electric loads are in the immediate area, transformers may be 50 kVA or larger. IDT usually provides grid-connected clinics with a vaccine refrigerator and a medical examination light, and possibly a two-way radio or other appliances as needed. Grid-connected clinics are also wired for AC if necessary – AC wiring costs are, in fact, absorbing an unexpectedly large proportion of IDT budgets.

IDT would like to see Eskom and other utilities involved in clinic grid-connection using low-cost technologies as far as possible, but in practice the choice of extension technology is left in the hands of the utility.

A2.1.3 Costs

Typical costs are R40 000 per km of grid extension (this includes a transformer at each clinic), and, so far, IDT expenditure has averaged about R150 000 per clinic connected. IDT may typically fund 90% of line extension costs, with the utility covering the remaining costs. The percentage of IDT funding is determined in negotiation with the utility, and is intended to consider the likely cost-recovery of the line as a result of connecting other users along the way – although, in practice, the available IDT budget is often the strongest determinant of its line funding; that is, it will try to spread its provincial grid extension budget over the number of clinics identified for grid connection.

In addition to extension costs, between R10 000 and R25 000 may be spent on upgrading electrical equipment and wiring at each clinic.

A2.1.4 Opportunities for cost reduction

As noted above, the use of low-cost technologies for clinic electrification via grid extension is left largely to the local distributors. Because line load forecasting plays an important part in determining the necessary capacity of the technology to be used, responsibility for such choices must lie with the local distributor (although it is likely that it will not consider each extension in sufficient detail to determine the load forecast in many cases, but merely use standard extension technology).

A2.1.5 Maintenance arrangements

Continued maintenance of grid connected clinics is not supported by IDT, but rather falls within the normal maintenance responsibilities of the utility.

A2.2 Residential clinic genset-plus-battery systems

A2.2.1 Technology used

A typical system comprises a 1 kW diesel generator supplying 36V DC power to a 200 Ah (@36V) battery bank, which in turn provides AC power to the clinic via an inverter. The vaccine refrigerator runs off LPG. The generator is housed in a lockable steel cabinet which is mounted on an external clinic wall. The batteries and inverter are housed inside the clinic in a wooden box.

Wiring is undertaken using an easily installed plug-in extension system which runs in the ceiling. Wiring is, apparently, installed within one day, which is quicker than normal clinic DC or AC wiring installation.

In order to increase the reliability of the vaccine refrigeration LPG supply, the following measures have been pursued:

- Oil companies are becoming involved in improving the reliability of LPG distribution networks.
- Vaccine refrigerators have a dedicated LPG supply using the largest available gas bottles (48 kg) with an auto-change-over regulator system when one bottle becomes empty - each refrigerator therefore has approximately one year's supply of gas when the bottles are full.
- Bottles are locked in to prevent theft.

Generator:	'Amandla 36' Lombardini diesel engine (rope start) Power output: 30A @ 36V (1.1kW) Fuel consumption: 1 litre per hour
Batteries:	6x12V modified SLI type units (36V configuration) capacity: 100Ah per unit (7.2 kWh of storage in total)
Charge regulation:	integral with generator 2-stage charging auto engine cut-out when batteries full, manual restart battery status indicator lights provided
Vaccine refrigerator:	runs off LPG (can also be powered by 12V DC or 220V AC) locally manufactured auto change-over LPG regulator with 2x48kg cylinder LPG supply

TABLE 15: Genset-plus-battery system technical information

Source: IDT (1995b)

A2.2.2 Costs

Cost estimates for diesel genset-plus systems are as follows (capital costs include any professional and contractor fees):

Large residential clinics: Capital costs R35 000; maintenance costs R5 000.

Small residential and day clinics: Capital costs R25 000; maintenance costs R5000.

A2.2.3 Opportunities for cost reduction

We are not aware of any detailed technical and financial analysis of these systems having been undertaken, so that cost-saving opportunities cannot be identified at present.

A2.2.4 Maintenance arrangements

Maintenance of genset-plus-battery systems will be the responsibility of the local Department of Works. Installation components are guaranteed for one or two years. To date, reports are that all pilot systems are working well and that clinic staff are pleased with them.

A2.3 Visiting point clinic power supply systems

IDT has recently issued a pilot national enquiry for remote area power supply systems for eight clinic visiting points in the KwaZulu-Natal region (IDT 1995a). Community halls associated with the visiting points (and, like them, built with IDT funds) may also be provided with power as a part of the contract. The industry has been asked to provide designs for systems deemed appropriate, and to detail installation and maintenance information, with costs clearly specified. The submissions by industry will be assessed by an adjudication committee, and one or more companies will be asked to submit a complete system prototype for evaluation by a technical committee. It is envisaged that, after the pilot project, the same contractor may be awarded more systems in the KwaZulu-Natal region, or in other provinces.

A2.3.1 The enquiry document

The enquiry document provides plans and photographs of all the sites in question. Information on light duty cycles in the visiting point and community hall is also given, as is the communications radio duty cycle. Loads to be supplied by the system are shown in Table 16. Lighting levels are not specified, and must be decided by the contractor.

Clinic visiting point:	Consulting and treatment room lights Store room light Exterior verandah light Medical examination light Communications radio
Community hall:	Internal lights External light

TABLE 16: Visiting point and community hall loads
Source: IDT (1995a)

The document suggests the following design parameters:

- Loss of power probability: 10% for lighting and 1% for the communications radio
- Load prioritisation: communications radio to take priority
- Installation: rapid installation is required
- Theft and vandalism: systems must be theft and vandal resistant
- Maintenance: maintenance requirements must be such that local staff can undertake the necessary tasks
- Life-cycle costs: this is to be considered in system design
- System expansion: as sites may be upgraded to full clinics in future, systems should ideally be easily expandable

A2.3.2 Costs

As no submissions have yet been received for the visiting point enquiry, no definite technical or cost information on these systems is available (the closing date for submissions is 14 August 1995). Cost estimates provided by the IDT are as follows (for PV systems):

- Visiting point and community hall: capital costs R35 000; maintenance costs R8 000.
- Visiting point only: capital costs R25 000; maintenance costs R5 000.

A2.4 Residential clinic PV systems

A2.4.1 Demand assessment

Several demand assessments of varying detail were undertaken prior to and during the IDT clinic electrification programme. These ranged from general needs assessments based on

interviews with clinic staff and other health authorities, and observation of activities at a number of clinics, through to detailed load assessments for specific appliances. Loads have been broadly categorised as shown in Table 17.

<i>Critical</i>	<i>Important</i>	<i>'Full' electrification</i>
essential clinic lights: - consulting room - post-natal room - delivery room clinic 2-way radio vaccine refrigerator	clinic lights: - waiting room - examination light nurses' home lights: - kitchen - lounge - bathroom	clinic lights: - dispensary - stationery room - treatment room - passage - toilet - front verandah - outside front - outside back nurses home lights: - bedroom 1 - bedroom 2 - outside front - outside back nurses' TV/radio powerpoint gatehouse lights: - pole-mounted light - guard house

TABLE 17: Typical clinic load categories

Source: EDG (1994a)

The 'full electrification' option has been chosen for all clinics in the IDT PV programme to date. Reasons for this include the fact that nurses are often reluctant to work in unelectrified clinics, with a resultant high staff turnover at these clinics. Electrification is therefore a means of improving the welfare of the nurses and thus staff motivation, which in turn improves the quality of service. Given the important role clinics have in rural development, particularly in their ability to reach poor households, it was felt that full electrification was worthwhile. The financial implications of providing different levels of PV electrification are explored later in this section.

Because PV systems typically require specialist refrigeration and other appliances (whether they are AC or DC, appliances for PV systems should be energy efficient), these are provided as a part of the installation. The programme also provides DC or AC wiring where it is required, although many clinics are pre-wired for AC as standard practice.

Lighting loads were determined using appropriate lux levels in each type of clinic room. Details of typical design loads used in clinic PV systems are given in Table 18.

Load description	Appliance power use (Watts)	Average consumption (Wh/day)
<i>Clinic building</i>		
Dispensary lighting	20	8.6
Stationery room lighting	20	2.1
Treatment room lighting	20	34.3
Consulting room lighting	20	34.3
Passage lighting	20	17.1
Toilet lighting	20	2.1
Waiting room lighting	20	17.1
Verandah lighting	20	8.6
Outside front light	11	11.0
Outside back light	11	11.0
Refrigeration (vaccine)	60	600.0
Two-way radio	100	7.1
<i>Maternity building</i>		
Delivery room lighting	20	102.9
Post-natal room lighting	20	25.7
Verandah lighting	20	20.0
Outside light	11	11.0
Examination light power point	30	12.9
<i>Nurses' home</i>		
Kitchen lighting	20	120.0
Lounge lighting	20	40.0
Front bedroom lighting	20	80.0
Back bedroom lighting	20	80.0
Bathroom lighting	20	40.0
Outside front light	11	22.0
Outside back lighting	11	22.0
TV/radio power point	20	100.0
<i>Gate-house</i>		
Pole-mounted light	18	144.0
Guard house	20	20.0
Total		1594

TABLE 18: Typical design loads for clinic PV system design
Source: EDG (1994a)

A2.4.2 Technology

The system configuration was determined by design criteria such as level of supply, compliance with WHO standards for vaccine refrigeration, and the actual conditions on site.

The PV systems are configured as two independent power supply and storage systems for two levels of priority of supply. A high priority system (System A) provides power to the most critical loads at 12 V DC, that is, vaccine refrigeration and two-way radio. A lower priority system (System B) supplies the power for general clinic lighting and the lighting and TV in the nurses' home.

The lower priority loads were supplied at 12 V DC in the initial installations, whereas in the more recent systems they use 220 V AC power through an inverter and standard AC wiring.

A unique feature of these clinic PV systems is the use of solar-bus charge regulation. This principle allows excess solar power to be diverted from either of the two PV arrays to the 'other' system's battery when that array's battery is full. This enables any excess power from array A, which is sized for extreme conditions, to be available for charging battery B, which is likely to be used more heavily for general clinic lighting and nurses' TV.

The solar-bus charge regulation retains complete independence of charging and discharging until either of the batteries is full. The solar-bus principle therefore utilises energy from the

arrays more fully and provides additional redundancy while retaining the reliability of modular components.

The two battery banks are protected against over-discharge by prioritised load-shedding of the loads. The refrigerator system incorporates a low voltage alarm to warn the staff to be careful in using or loading the refrigerator. In addition, the lights and TV in the nurses' home are programmed to loadshed before those in the clinic, to prevent loss of power in the clinic due to excess consumption in the nurses' home.

PV array:	Peak rated power:	2 x 6 45 W _p modules 540 W _p @ STC
Battery:	Cell capacity:	2 x 6 cells 332 Ah @ 100 hr rate
Charge regulator:	Nominal voltage: Charge rating: Discharge rating:	solar bus 12 V 2 x 30 A 2 x 30A
Inverter:	Waveform: Rated power: Surge rating: Efficiency:	sine wave 500 VA 250% for 120 seconds 91% @ 100 W 88% @ 500 W
Vaccine refrigerator:	Volume: Energy consumption:	chest type 60 litre 420 Wh/day @ 43°C
Indoor/outdoor lights:	Rating: Outdoor sensor:	compact fluorescent 20 W passive infra-red
Streetlight:	Rating:	pole-mount (6 m) 18 W
Examination light:	Rating: Angle of illumination:	Dichroic halogen 50 W 8°

TABLE 19: Technical information on a typical residential clinic PV system
Source: EDG 1994b

A2.4.3 PV system performance

The systems are designed to provide reliable vaccine refrigeration at between 0°C and 8°C at ambient air temperatures of up to 43°C. In addition, the systems are designed to provide the following lighting levels:

- General indoor 50 - 100 Lux
- Medical examination 1300 Lux
- Streetlight 5 Lux

In terms of net electrical energy available (i.e., the amount of electricity supplied), the combined DC systems are designed to yield an overall annual average of approximately 1.6 to 2.0 kWh/day depending on the location. The combined DC and AC systems are likely to supply between 1.2 and 1.6 kWh/day. The lower energy availability for AC is due to losses incurred as

a result of the expected average daily inverter efficiency of approximately 75 - 80%. The reduced energy availability applies only to the general lighting and TV loads (System B) since DC distribution is retained for the critical loads.

The generating power and battery storage capacities are sized to provide the full daily energy availability for more than 363 days per year (99.5%) for the critical loads (System A) and 346 days per year (95%) for the general lighting and TV loads (System B).

A2.4.4 Choosing between DC and AC

Initially, only DC clinic systems were provided. The main reasons for this were the lower cost, greater simplicity and anticipated greater robustness of DC systems. However, over time it became apparent that predominantly AC systems were more appropriate, and now all systems installed are predominantly AC (although the refrigerator system remains DC). The main reasons for the decision to use AC rather than DC related the greater availability of AC appliances, the greater capacity in rural areas to work on AC rather than DC systems, and the increasing availability of robust, efficient inverters. A more detailed comparison between AC and DC is shown in the box below.

Comparison between AC and DC

Advantages of AC over DC

AC allows simpler installation (no DC wiring – clinics often pre-wired for AC)

AC allows easier grid linking in future

AC allows more of the system to be re-used if the clinic is grid connected

AC wiring and maintenance can be done by local electricians, not solar specialists

AC allows standard and easily available appliances (TV, light bulbs etc.) to be used

Disadvantages of AC

AC has to rely on inverters, which can have poor efficiency and be of questionable robustness

AC systems are more complex than DC systems

AC wiring must be inspected by a qualified AC 'wireman', while no inspection of DC wiring is needed

AC facilitates greater user-abuse through use of non-efficient appliances (e.g. incandescent bulbs, old inefficient colour TVs etc.)

AC systems are usually more expensive than DC systems for equivalent energy provided.

Source: EDG (1994a)

A2.4.5 PV system costs

The total cost of the supply and installation contract including spares, user training, maintenance for twelve months, consultant's fees and VAT is typically R55 000 to R60 000 per clinic. To cover the system maintenance for the first ten years of a system's life, the IDT has set aside about R15 000 per system in a Joint Maintenance Fund.

Phase	Task/item	Consultants fees & disbursements (R)	Contractors costs (R)
Design	Design & tender documentation	3 000	
	Tender analysis & appoint contractor	1 600	
Installation	Site visit with contractor	1 700	
	Equipment: PV modules		9 000
	Equipment: regulators & appliances		12 900
	Equipment: batteries		3 900
	Installation inspection	1 700	
	Installation & BOS ¹ costs		16 900
	Commissioning tests & handover	2 600	1 800
Maintenance	6-month check		1 400
	12-month check		3 300
Totals		10 600 ²	49 200
Total		R59 800	

1 Balance of System (wiring, connectors, switches etc.)

2 Approximately R7 800 of this amount is consultant's fees and R2 800 is disbursements

Note: VAT is excluded

TABLE 20: Typical clinic project cost breakdown (for one clinic)

Source: EDG (1994a)

A2.5 Tender process and installation of PV systems

The clinic PV system is designed based on general clinic system performance requirements (see above) and on a demand assessment informed by a visit to each site. Either the consultant or IDT fieldworkers undertake this assessment. (In most cases, full as-built drawings have needed to be draughted as a basis for design and project supervision.)

A2.5.1 Tender process

Tender documents are compiled for each installation contract - an example of this is provided in the document by EDG (1995). This document is prepared in accepted engineering format, and includes the following:

- general and specific conditions of contract;
- standard and specific project specifications for PV systems (the latter specifies the system design);
- site plans and building layout diagrams;
- diagrams: electrical circuits, distribution board layout, typical components, mounting details;
- schedule of information on system components (to be completed by contractor);
- schedule of prices (to be completed by contractor).

Variations to the specifications are permitted, but must be clearly pointed out and justified by the contractor. A typical price breakdown may request prices per clinic for a ten clinic project, with specified discounts should the project be expanded to include more clinics.

A notice of the tender is published in the *Engineering News* newspaper, and all organisations within the industry which may be interested in tendering are also contacted specifically. The tender period is typically three weeks after advertising the tender.

Once tenders have been submitted to the consultants, they are evaluated according to accepted engineering practice. The evaluation considers the following:

- price for installation, equipment and maintenance;
- acceptability of any alternatives offered;
- quality of equipment offered;
- subcontractor capabilities and experience;
- system life-cycle cost analysis;
- installation programme;
- capabilities and experience of the contractors.

Testing of equipment is undertaken by the consultant where it is felt that component performance and quality need to be confirmed. Contractors are required to submit equipment for testing on request of the consultant.

Based on the evaluation, a recommendation is then made to the IDT, which establishes an adjudication committee to consider the recommendation and finalise an appointment. The adjudication committee may typically consist of representatives of the DMEA, DBSA, Eskom and EDRC. In practice, the consultant's recommendation is often accepted without modification. After appointment, a contract is entered into between the client and the contractor.

The IDT's tender award policy centers around open competition – that is, the lowest *competent* bidder will be awarded the contract. In practice, this has led to one of the smaller firms being awarded most contracts, as they have been able to keep costs low enough to undercut most of the PV industry by a significant margin.

A2.5.2 Installation and commissioning

After tender award and appointment, the installation is undertaken by the contractor. Pre-installation site visits are first undertaken to confirm clinic localities and equipment location within the clinic, and to liaise with clinic staff. The consultant generally inspects installations after systems at one or two clinics have been completed in order to correct any quality problems early in the contract. Another inspection during the installation phase may also be undertaken by the consultant if considered necessary. On completion of the installations, commissioning (or acceptance) tests are undertaken by the consultant. The nature of these tests is laid out in the general specification section of the tender document, so the contractor is aware of the performance standards required from the outset. The acceptance tests include:

- array tests (IV and other measurements);
- battery tests (cell SG's and capacity tests);
- inverter tests (standby power draw, efficiency);
- regulator tests (voltage set points, indicator light functioning, efficiency);
- wiring tests (voltage drops); and
- lighting level measurements.

A2.6 PV electrification: opportunities for cost reduction

An analysis of cost-reduction potential was undertaken during the PV clinic electrification programme, with the objective of exploring various system configurations and levels of supply to determine if significant savings could be realised without compromising system quality and impact on rural health. The following cost-saving areas were investigated (EDG 1994a):

A2.6.1 System design and configuration modifications (without changing the design load)

Although minor equipment savings are possible by simplification of the system configuration (simpler distribution boards, for example), the most promising area of potential savings relates to simplifying the installation effort required (installation costs are about 20 to 30% of total contractor costs). Saving techniques considered here were the use of modular systems (for

example, pre-assembled and tested battery-controller-inverter systems could be containerised in a central workshop ready for placement on site), and the use of existing AC wiring where available. However, the former is likely to be cost effective only on large projects where installers can realise economies of scale and overcome extra system development costs; the latter requires incurring the extra cost of an inverter, which can nullify the reduced wiring costs. The overall savings by such methods are therefore not significant in the short term, although it is felt that 'containerised' systems should be further explored and developed by the solar industry (such containers will also be very easy to remove should systems be connected to the grid in future).

A2.6.2 Reduced system design load

Total costs reduce roughly proportional to the design load, and therefore the feasibility of removing some of the less critical loads needed to be examined. The first loads to be dispensed with would be those such as the outside lighting, nurses' bedroom lighting, or the radio/TV powerpoint for the nurses. This would undoubtedly reduce the value of the system to the clinic staff. Loads such as these are usually relatively small compared with the refrigeration load for example, and savings are therefore likely to be small (around 10-20%), a saving which may not be justified in view of the resulting reduced value of the system to the staff. More major reductions in level of supply would be needed to realise significant savings. This would require a shift in policy, however, and care should be taken to fully evaluate the appropriateness of such a move (at present the policy is for 'full' electrification). Table 21 shows system costs and savings for reduced design loads.

	<i>Critical loads only¹</i>	<i>Critical and important loads only</i>	<i>'Full' electrification</i>
Design load	770 Wh/day	1000 Wh/day	1594 Wh/day
System cost (contractor)	R 26 400	R 32 500	R 49 200
Total project cost (approx - incl. consultants)	R 33 500	R 40 600	R 60 000
Savings compared with full electrification	44 %	32 %	0 %

1 'Critical' and 'important' loads are defined in Table 17

TABLE 21: Cost savings for different design loads (per clinic)
Source: EDG (1994a)

A2.6.3 Reduced consultant involvement

To date, the IDT project consultants (Energy Development Group) have been closely involved in most phases of all PV clinic electrification projects undertaken. Reduced involvement from consultants (and thus cost savings) is possible where the capacity to supervise contracts exists in project areas (within the local utility or Department of Health/Works, for example). Such capacity is generally lacking at present, but could be developed over the medium term with a training programme or by closer local involvement in current projects alongside EDG or other consultants. Another possible cost-saving mechanism would be to place more responsibility with the installers to deliver a product of the required quality, and thus reduce the supervision required from consultants. Project experience to date, however, suggests that substantial involvement from consultants has been necessary to ensure quality, although this may change over time as industry becomes familiar with the standards considered acceptable. It is probably worth considering that extensive involvement of consultants in most engineering projects is a tried and tested system of interfacing between client and contractor, and while it is likely that industry could take on more responsibility in future, the fundamental function of the consultant could probably not be easily dispensed with.

Table 22 illustrates potential cost savings by reduced consultant involvement. The following scenarios are considered:

1. *Full consultant involvement* (current situation): the consultant covers needs assessment, design, tender, installation supervision and commissioning aspects of the project.

2. *No consultant supervision of installation:* initial site visits and installation supervision are undertaken by local utility or Departmental staff, and they also support the consultant in obtaining design information for the tender specification.
3. *Advisory consultant to local utility or Department of Health/Works only:* design and tender undertaken by local utility or Department staff with consultant support. All supervision undertaken locally, with consultant support for system commissioning.
4. *Minor consultant involvement only:* consultants essentially only provide an advisory service to the local utility or Department on certain project aspects.

	<i>Full consultant involvement</i>	<i>No consultant installation supervision</i>	<i>Consultant in advisory role</i>	<i>Minor consultant involvement</i>
Consultant's fees (approx)	R 7 800	R 5 500	R 1 900	R 600
Saving on consultant's fees	0 %	30 %	76 %	92 %
Saving on total project cost	0 %	4 %	10 %	12 %
Consultant's % of contractor costs	16 %	11 %	4 %	1 %

TABLE 22: Cost savings by reducing involvement by consultants (per clinic)

Source: EDG (1994c)

A2.6.4 Opportunities to streamline the PV system tender procedure

During the clinic electrification programme, a brief analysis was undertaken on potential measures which could streamline the tender process (EDG 1994a). The main conclusions are summarised in this section.

The feasibility of simplifying the specification or streamlining the tender process was found to be limited, although the potential was noted for contractors to be given more responsibility in system configuration and components in future. The overall conclusion was that the tender process is currently not unduly cumbersome nor the specification too demanding for the size of project, considering the lack of experience within the industry with this type of installation and the inconsistent track record of the PV industry to date.

Nevertheless, over the past years the tender system has been simplified by allowing contractors to quote for typical systems rather than for each and every installation. Contract price is then determined by extending the quote over the full scope of the project using detailed rates provided by the contractor.

A2.7 Maintenance arrangements for PV systems

A2.7.1 Guarantees

As a part of the contractor's obligations, the entire PV system is guaranteed for twelve months, and any component failure during this period not resulting from user-abuse must be made good by the contractor at no cost. The contract also requires that PV panels be guaranteed for ten years.

A2.7.2 One-year maintenance contract

As a part of the installation contract, the contractor must undertake system maintenance for one year after system hand-over. This involves two six-monthly visits to check system operation and perform basic maintenance tasks (such as battery electrolyte and voltage checks, appliance performance observation, array and regulator functioning). The maintenance visits and any component replacements must be recorded by the contractor on a standard form, and submitted to the consultant and the client

Although most systems have not been installed for long enough to evaluate the maintenance procedure properly, to date contractors have maintained systems adequately and replaced components where this has been necessary. A noteworthy problem concerns the DC lights installed in four clinics in Venda, of which about 50-60% have failed. These lights have not previously been tested, and thus may be of inferior quality; they will be replaced by the contractor.

A2.7.3 Spares

A full set of spares is stored at the provincial Department of Health offices as a part of the installation contract. These usually include: PV modules, one complete battery bank, a charge regulator, an inverter, a vaccine refrigerator and light bulbs.

A2.7.4 Long-term maintenance

IDT recognises that longer-term maintenance is an important part of a clinic electrification programme. It has therefore established a Joint Maintenance Fund, in which money is deposited for continued maintenance of installed clinic PV systems for the next ten years. This amounts to approximately R15 000 per clinic. Initially it was anticipated that Eskom would also be a substantial contributor to this fund, but no money has been received from this source, and IDT considers their future participation in the fund unlikely.

The IDT sees that ownership of the systems will rest with the provincial Departments of Health (or possibly Works, depending on the region), and that they will initiate and supervise maintenance contracts with the PV industry, or possibly undertake it in-house. They will be obliged to take responsibility for proper maintenance arrangements if they are to access the Joint Maintenance Fund. However, as all systems installed are still within their one-year guarantee period, ownership of systems has not yet been officially transferred, nor has maintenance been handed over to the relevant departments. The practicalities of how the longer-term maintenance arrangements will work are therefore still untested.

A2.8 User training and regional capacity building

A2.8.1 User training

User training is a component of the residential PV clinic electrification installation contract, and so is undertaken by the contractor. IDT contracted EDG to develop a generalised user training booklet for this purpose, but the contractor is also required to produce a system-specific operation and maintenance manual, and both documents are used in the training and are left on site. The objective is to provide users with enough information to understand the basic operation of the system, use energy sparingly, and perform basic 'first-line' maintenance tasks (such as checking the battery electrolyte level, replacing light tubes, cleaning PV panels). In future, IDT may also produce training videos for clinic staff.

A2.8.2 Regional technical capacity building

Early in the project it was considered that development of local technical capacity to repair and maintain clinic PV systems was necessary if the project was to be sustainable. A slightly different approach is now being followed, where responsibility for sustaining system operation will be left more to provincial Departments of Health or Works, and IDT will focus on building the energy capabilities of their fieldworkers (although this training will also be open to participation by relevant provincial government departments). The scope of this training will probably not place them in a position to perform repairs or more complex maintenance tasks. IDT funded the development of a technical guide to facilitate such capacity building (the guide is available in draft copy from EDG).

A2.9 Recent developments in the IDT programme

A2.9.1 'Model Clinics' programme

In order to give the whole PV industry an opportunity to participate in the IDT clinic electrification programme, IDT intends to launch a 'Model Clinics' programme. Support for this project is likely to be forthcoming from the US Department of Energy. The project involves asking all firms who wish to participate to install systems at two or three clinics of IDT's choice.

Firms are expected to document exactly what costs were incurred, and IDT covers these costs. IDT then will be able to evaluate the quality of the resulting installations, and will be able to ask the most competitive firms to undertake larger-scale projects based on the quality and costs delivered in the 'Model Clinics' installations. It is further envisaged that IDT fieldworkers will be involved in acceptance checks for this programme.

It is uncertain what the outcome of this programme will be, and it is not unlikely that the same firms that have consistently been the lowest bidders for the regional project tenders will come out as the most cost-effective options in the 'Model Clinics' programme. This programme will, however, allow other firms in the PV industry to define costs and risks of PV clinic electrification more closely, which could enable them to submit more competitive offers in future. It also allows the PV industry freedom in terms of specific technology choice, which could lead to some innovative and low-cost solutions being developed. IDT intends to undertake this programme soon, and its results will influence the future implementation methodology for clinic PV installations.

A2.9.2 National enquiry

Instead of using the tender route, the IDT may issue a national enquiry. This involves requesting submissions on the design, installation and supply of systems from the industry. Prices must be specified. An adjudication committee then evaluates the submissions in terms of technical soundness, price, and practicality. The enquiry process allows for greater flexibility than a tender, as the system type and configuration is left entirely up to the industry. IDT has very recently issued a national enquiry for remote area power supply systems to electrify health visiting points and community halls. Responses have not yet been received. IDT is also considering the national enquiry route for further genset-plus-battery systems for residential clinics.

A2.9.3 Clinic visiting points

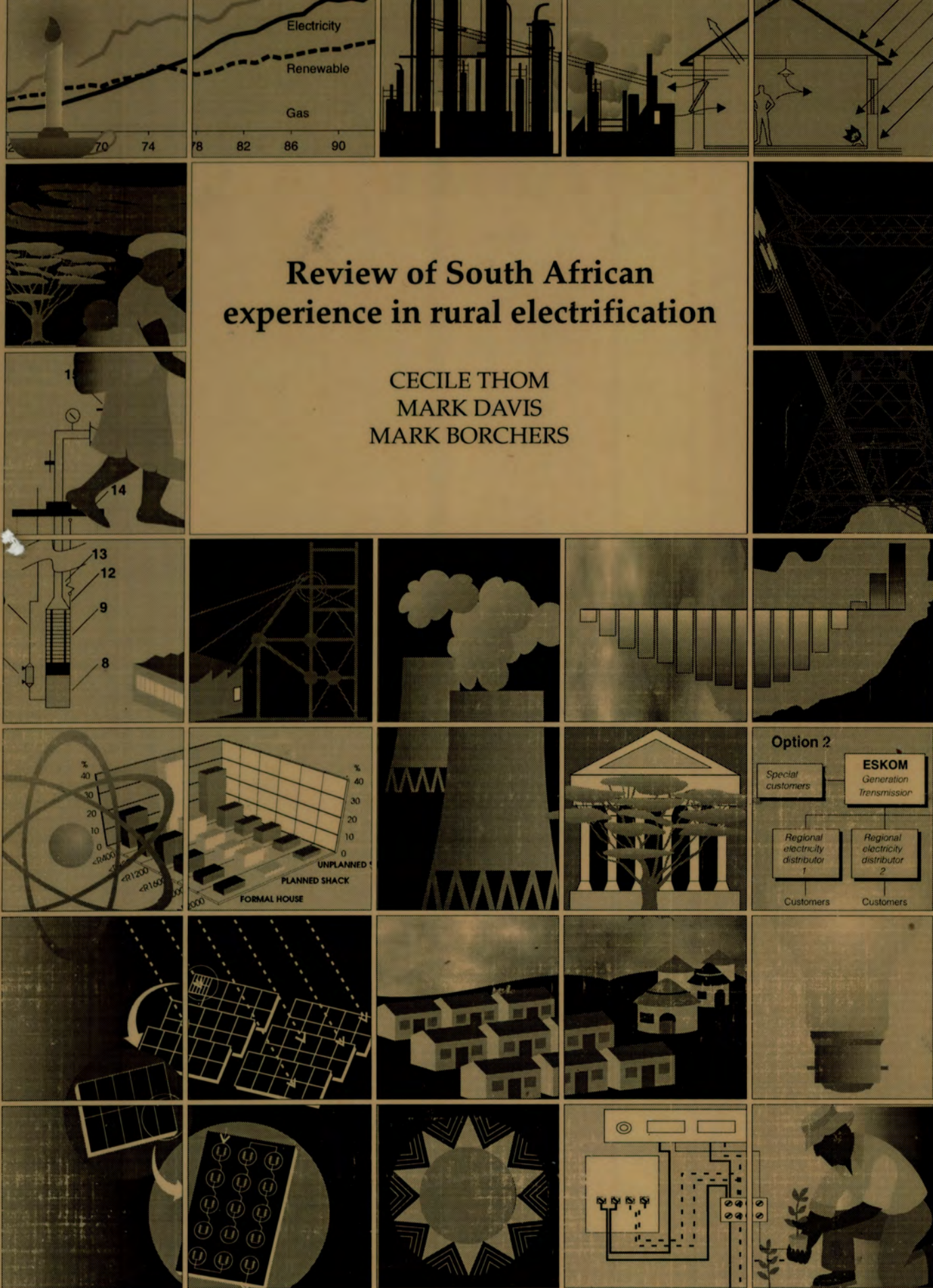
A pilot national enquiry has recently been issued, and covers eight KwaZulu-Natal visiting point and associated community hall remote area power supply systems in KwaZulu-Natal. IDT intends to provide power to all the country's remaining visiting points (about 200 in total) after this initial phase.

A2.9.4 Genset-plus-battery systems

A pilot genset-plus-battery installation project has recently been undertaken by IDT using a specific company in the North-West Province. The company undertook system configuration (design) and installation work. A national enquiry or tender for the supply and installation of further systems is planned as a next step.

A2.9.5 Rural hospitals

It has become apparent to IDT that many rural hospitals have seriously inadequate energy supplies, and that therefore substantial budget reallocations will be necessary if this critical link in rural health care is to receive attention. An example was given where a hospital was connected to the grid, but the local utility refused to switch on the power due to the degraded condition of the hospital's wiring system.



Review of South African experience in rural electrification

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